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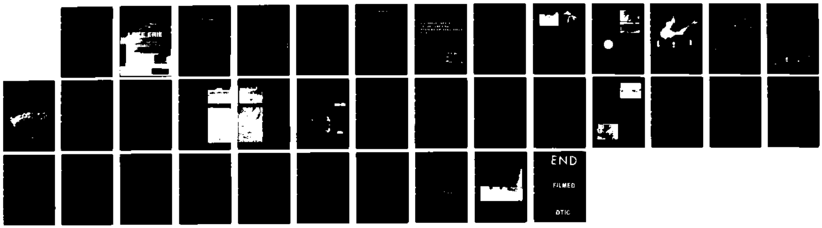

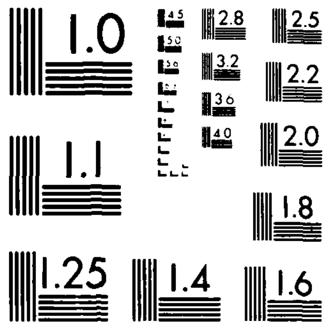

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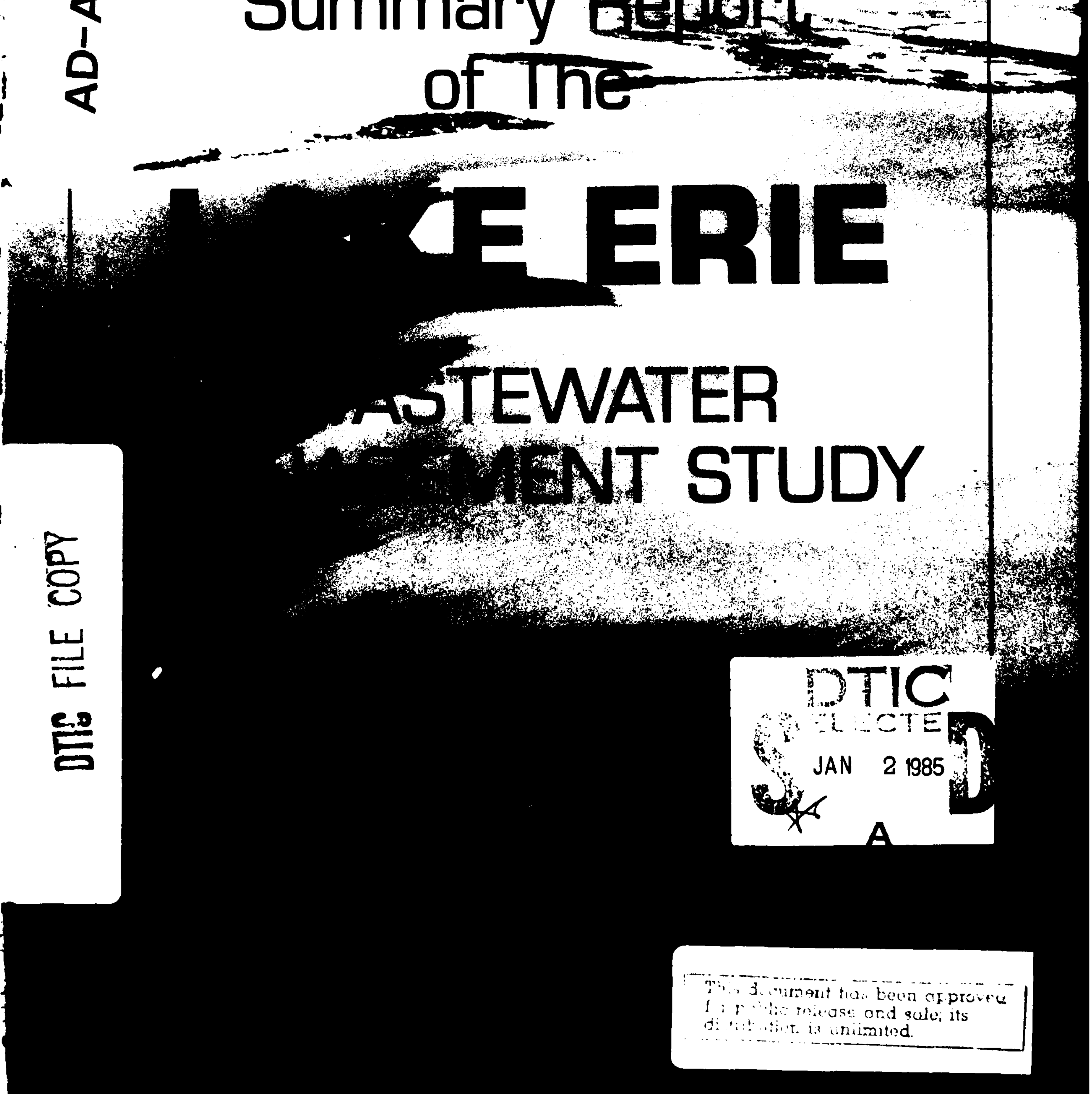
Summary Report of The LAKE ERIE WASTEWATER MANAGEMENT STUDY



ACKNOWLEDGEMENTS

This report could not have been completed without the assistance of the following members of the LEWMS staff: David A. Melfi, who developed the three basin phosphorus budget model, the data management system and made the loading calculations; John R. Adams who was responsible for the Land Resource Information System and developed the phosphorus loading reduction scenarios; Fred Boglione who developed the cost of phosphorus reduction at municipal wastewater treatment plants and by urban diffuse source control; and Richard Leonard who wrote several chapters of the report. Sophia Baj, April Zimmerman and Tom Adolph also made contributions to the production of the report.

Thanks are also due to the following technical consultants to the study: Dr. Terry J. Logan of Ohio State University who wrote the biological availability section and developed cost effectiveness of different Best Management Practices for phosphorus reduction; Dr. Lynn Forster of Ohio State University who wrote the economic analysis; Dr. Donald Eckert of the Cooperative Extension Service of Ohio State University who gathered the crop yield data from the demonstration projects and wrote the section on the proposed program; Dr. David Baker of Heidelberg College who did the river transport studies and made a major contribution on that subject for the report.

Donald R. Urban, George Stem and Bruce Julian of the Soil Conservation Service were assigned to this study at different times. Their advice was valuable and they made a large contribution to the success of the demonstration projects. John Crumrine, Project Manager of the Honey Creek Project, showed that a technical assistance program for conservation tillage was a feasible approach for reducing phosphorus loads from agriculture.

A special thanks goes to Mrs. Freda Soper who prepared this manuscript.

STEPHEN M. YAKSICH
Project Manager

About The Cover: The cover photograph is of a sediment plume entering Lake Erie from the Sandusky River thru Sandusky Bay. The plumes of the Portage and Maumee Rivers can be seen in the background. The Lake Erie Islands are seen to the right. Source: Heidelbert College Water Quality Laboratory.

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This summary provides an overview of the findings from the Lake Erie Wastewater Management Study. After nearly a decade of investigation, considerable information has been obtained concerning the extent of Lake Erie's water quality problems, the causes of these problems, and a cost-effective strategy to improve Lake Erie's water quality.

Numerous questions remain unanswered about the exact relationship between land use and water quality and about the effectiveness of the proposed

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management strategy. However, enough information has been assembled in oorder to project that Lake Erie can be rehabilitated with the recommended program at a relatively low cost.

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A SUMMARY REPORT OF THE LAKE ERIE WASTEWATER MANAGEMENT STUDY.

INTRODUCTION

It has been recognized for many years, dating back to the 1960's, that the lower Great Lakes, and in particular Lake Erie, have been damaged as a result of cultural activities within the Great Lakes Basin. Section 108(d) of the 1972 Federal Water Pollution Control Act recognized the serious conditions which exist in Lake Erie and directed the Secretary of the Army, acting through the Chief of Engineers, to "develop a demonstration wastewater program for the rehabilitation and environmental repair of Lake Erie." Work began in 1973 and has culminated in this 1982 final report and implementation recommendations. The boundaries of the 20,400-square mile U.S. portion of the Lake Erie Basin and the principal subbasins are shown in Map I.

The proposed program consists of accelerated implementation of conservation tillage on suitable basin cropland. Educational, technical assistance, and demonstration projects in each of 20 western basin counties will provide the catalyst needed for accelerated adoption of the soil and phosphorus saving conservation tillage practices. It is estimated that the $12.3 million, 10-year program will achieve a 55 percent reduction in cropland soil erosion by the year 2000 and reduce phosphorus loadings to the lake by 2,030 metric tons per year by that date. It will also meet the U.S. obligation for diffuse phosphorus reductions required by the 1978 Great Lakes Water Quality Agreement.

Nature of the Problem

The major Lake Erie water quality problem which this program focused on may be succinctly described as "overenrichment." Heavy inputs of the plant nutrients phosphorus and nitrogen have resulted in a lake condition referred to as "eutrophic." Eutrophic lakes are characterized principally by profuse algal growth. While algal blooms are not in themselves harmful, decay of the algae often results in oxygen deficiency, especially in the Central Basin of Lake Erie. Oxygen deficiency in turn results in fish kills, and replacement of important sport and commercial fish species with less desirable species, as shown in Figure 1. Other problems

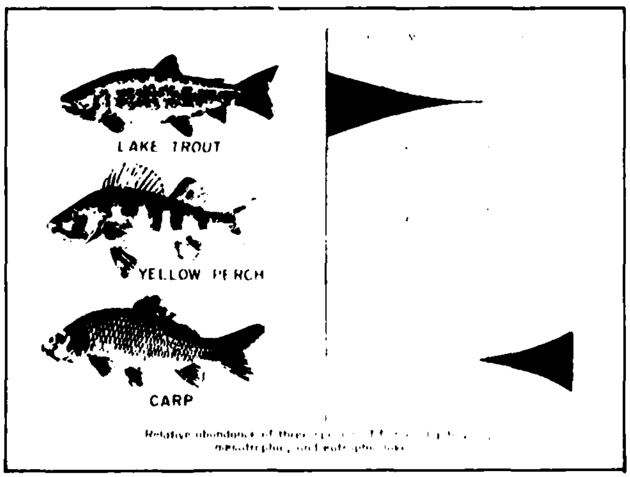
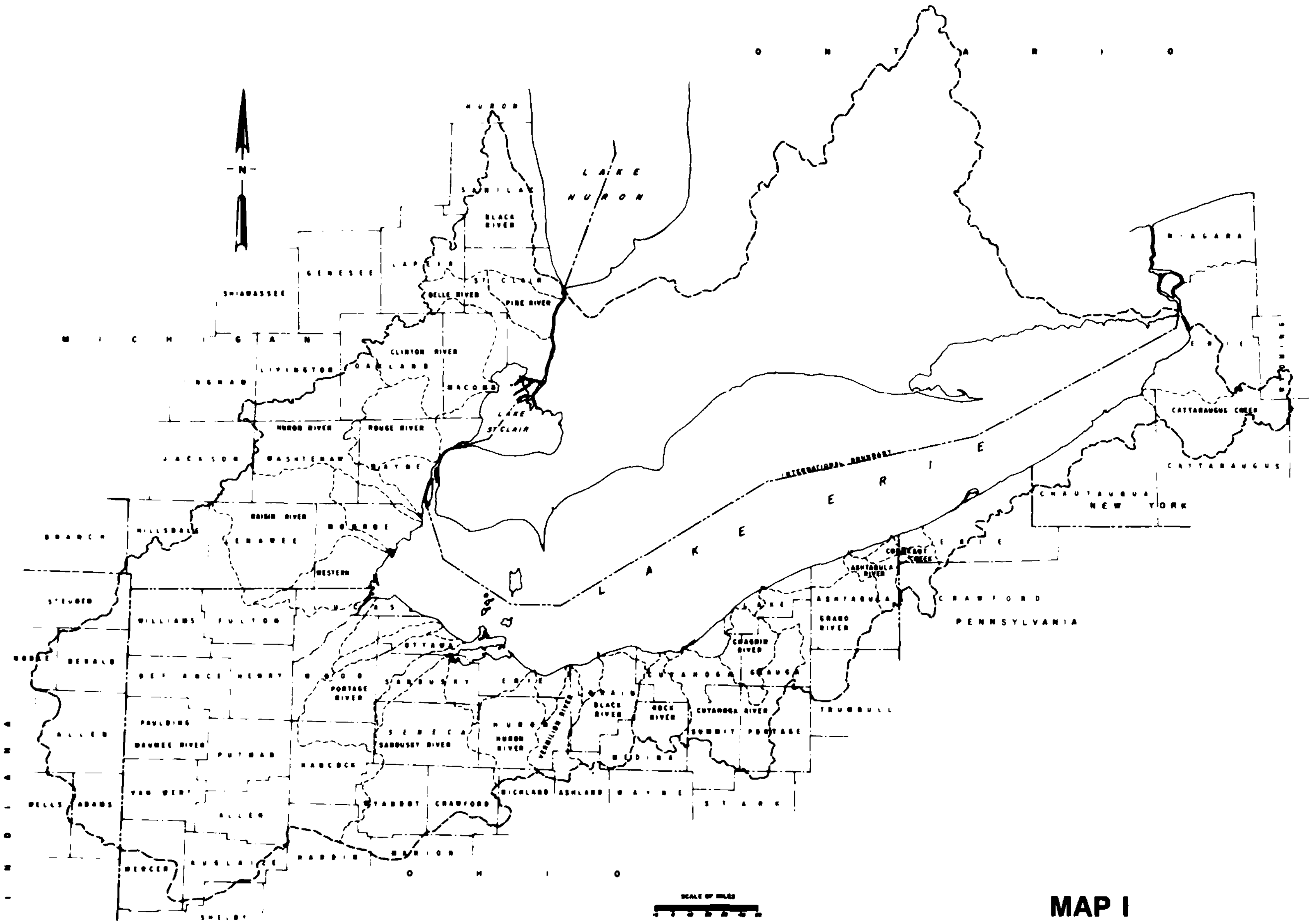


Figure 1
Fish Abundance in Eutrophic Lake.



MAP I
LAKE ERIE DRAINAGE BASIN

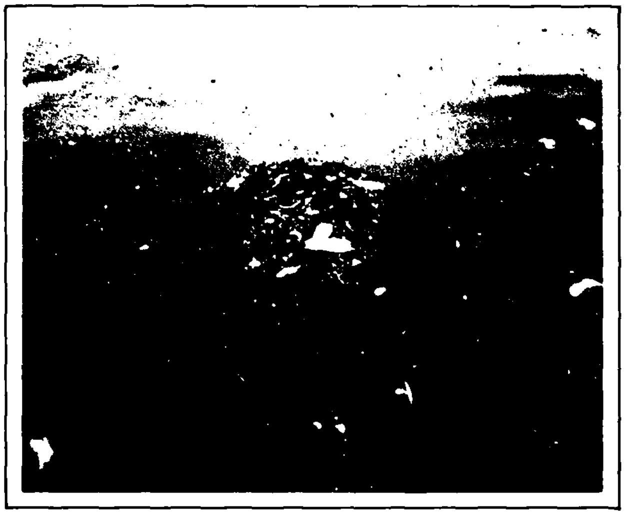


Figure 2
Algal Blooms.

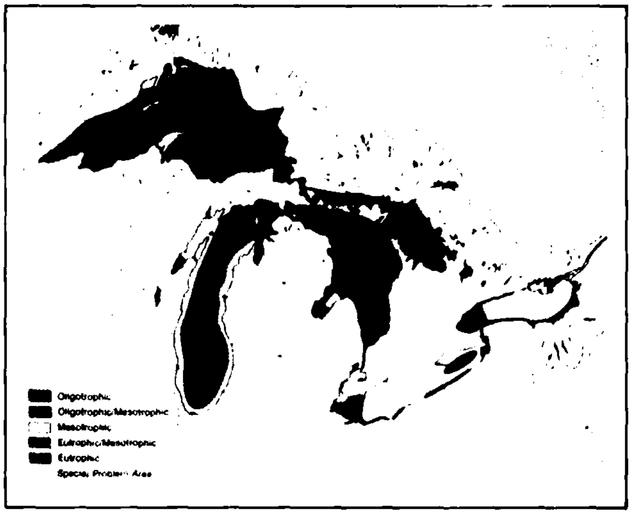


Figure 3
Degree of Lake Erie Eutrophication.

associated with algal blooms and their decay are turbidity, odor problems, tainting of water supplies, and unsightly algal blooms, as shown in Figure 2. The degree of Lake Erie eutrophication compared to other Great Lakes is shown in Figure 3. Extensive research has shown that the major contributor to Lake Erie eutrophication has been the oversupply of phosphorus which stimulates excessive algal growth.

Sources of Phosphorus

Having recognized that phosphorus input is a major problem, it then becomes necessary to determine the sources of phosphorus to the lake. Major sources of phosphorus include Municipal wastewater treatment plant discharges which are referred to as "point" sources, and land runoff sources which are referred to as "nonpoint" or "diffuse: sources. Other sources include input from Lake Huron and fallout from the atmosphere.

Figure 4 illustrates estimates of present (1980) phosphorus loadings to Lake Erie from the various sources. There is, of course, yearly variability in inputs especially from land runoff. Total phosphorus loading is about 16,500 MT per year (multiply by 1.1 to convert to tons). About 4,500 MT per year is from point sources and 9,300 MT per year from nonpoint sources. Loadings have decreased from about 20,000 MT per year to the 16,500 MT per year level due to the construction of large municipal treatment plants in the basin which reduce phosphorus concentrations in effluent to 1.0 mg/l or less. As will be discussed, the costs of achieving further reductions through further removal of phosphorus at treatment plants is disproportionately high. Thus, the Lake Erie Wastewater Management Study (LEWMS) turned to achieving phosphorus reductions from land runoff. Investigation during the LEWMS program determined that of the 9,300 MT per year phosphorus load from non-point sources, 8,400 MT, or 51 percent, of the total lake loading is contained in runoff from rural land, principally agricultural cropland. Therefore, the LEWMS program was directed towards investigating how phosphorus runoff from cropland could be effectively reduced with practical cost effective methods which do not adversely affect crop yields or economic return to the farmer.

Lake Erie Phosphorus Loading Objective

The International Joint Commission (IJC), after intensive study of phosphorus inputs to Lake Erie and resultant effects, set a long-term total phosphorus loading goal of 11,000 MT per year. Attainment of this loading objective is expected to lead to a 90 percent reduction in the area of severe oxygen deficiency (anoxia) in the central basin of Lake Erie. The immediate IJC goal is to reduce nonpoint source loadings by 2,000 MT per year with 1,700 MT of that reduction from the United States.

RELATIONSHIP OF SOIL EROSION TO PHOSPHORUS LOSSES

As a prerequisite to developing a strategy for controlling phosphorus inputs to Lake Erie, it is necessary to understand how intimately phosphorus is attached to soil and the mechanisms fo' detachment and transport of sediment and phosphorus to the lake. Further, it is necessary to know the availability of the transported phosphorus for algal growth.

Phosphorus in the soil exists for the most part as compounds of low solubility. Even soluble phosphorus fertilizers quickly revert to insoluble forms. Thus, phosphorus compounds behave as if they were soil par-

ticles when subjected to the erosive force of water.

Soil erosion in the Lake Erie Basin occurs mainly as sheet and rill erosion. These erosion processes are illustrated in Figure 5. Sheet and rill erosion is defined as the detachment and transport of soil particles by raindrop impact and water runoff. The largest component of sheet erosion occurs with the initial raindrop impact. Soil particles are dislodged and suspended in the water. When this water runs overland it may detach additional soil particles or drop some of the previously suspended soil. As this water collects into concentrated channels, its energy is again increased to the point that it can erode soil, and rills are formed as the flow cuts into the soil.

These channels are considered rills until they can no longer be obliterated by annual tillage operations. beyond this point, rills become gullies. Sheet and rill erosion of agricultural lands account for most of the nonpoint source loading of total phosphorus to Lake Erie. The factors which affect sheet and rill erosion from agricultural lands involve land use intensity, land form, soil type, and climate. The vegetative cover on a particular parcel of land can easily dominate all other factors in assessing the potential and the rate of sheet and rill erosion. Row crops such as corn and soybean which

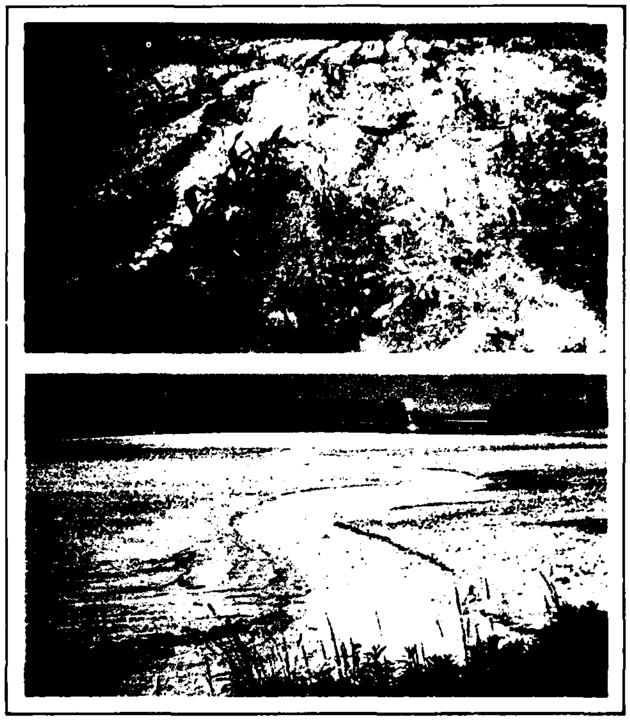


Figure 5
Soil Erosion in Lake Erie Basin.

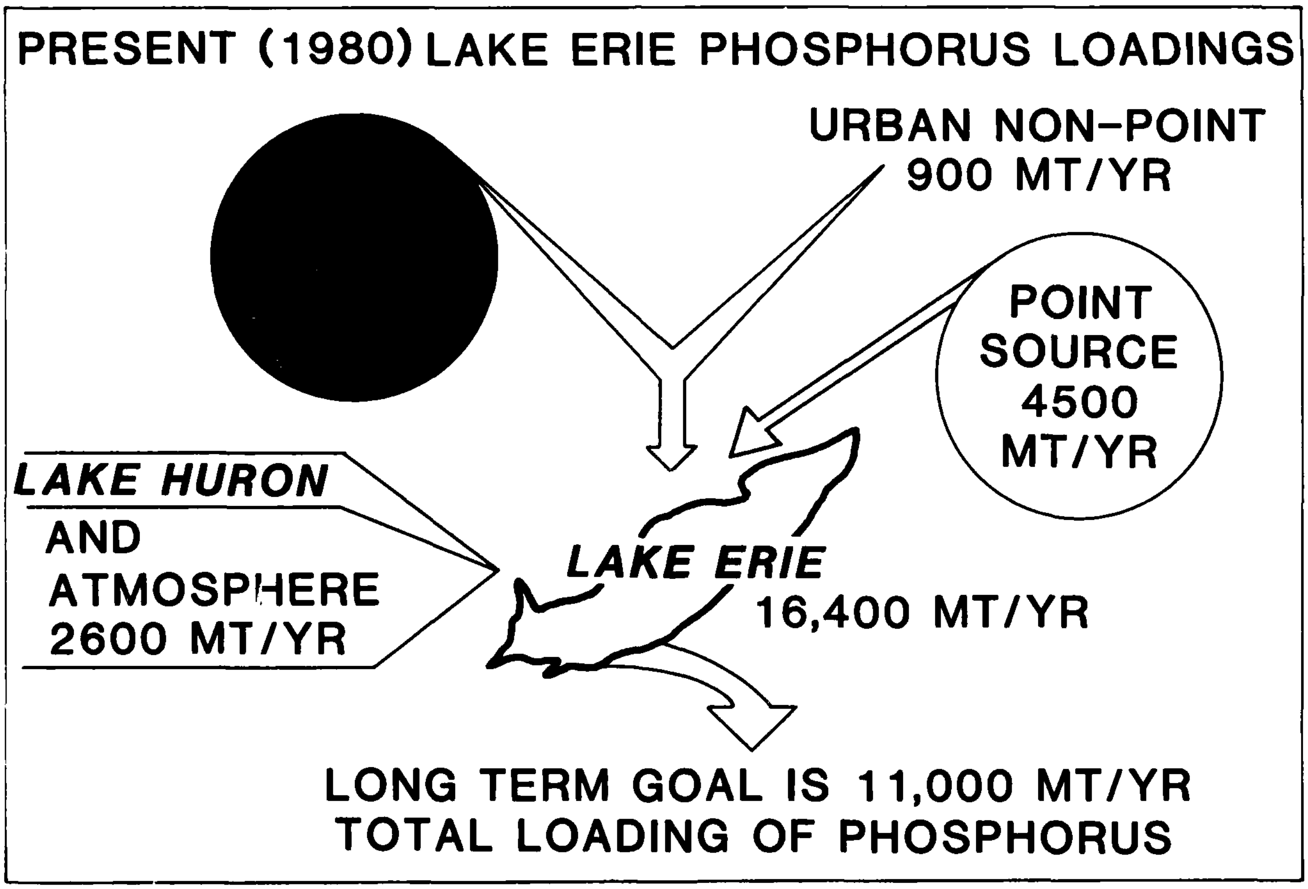
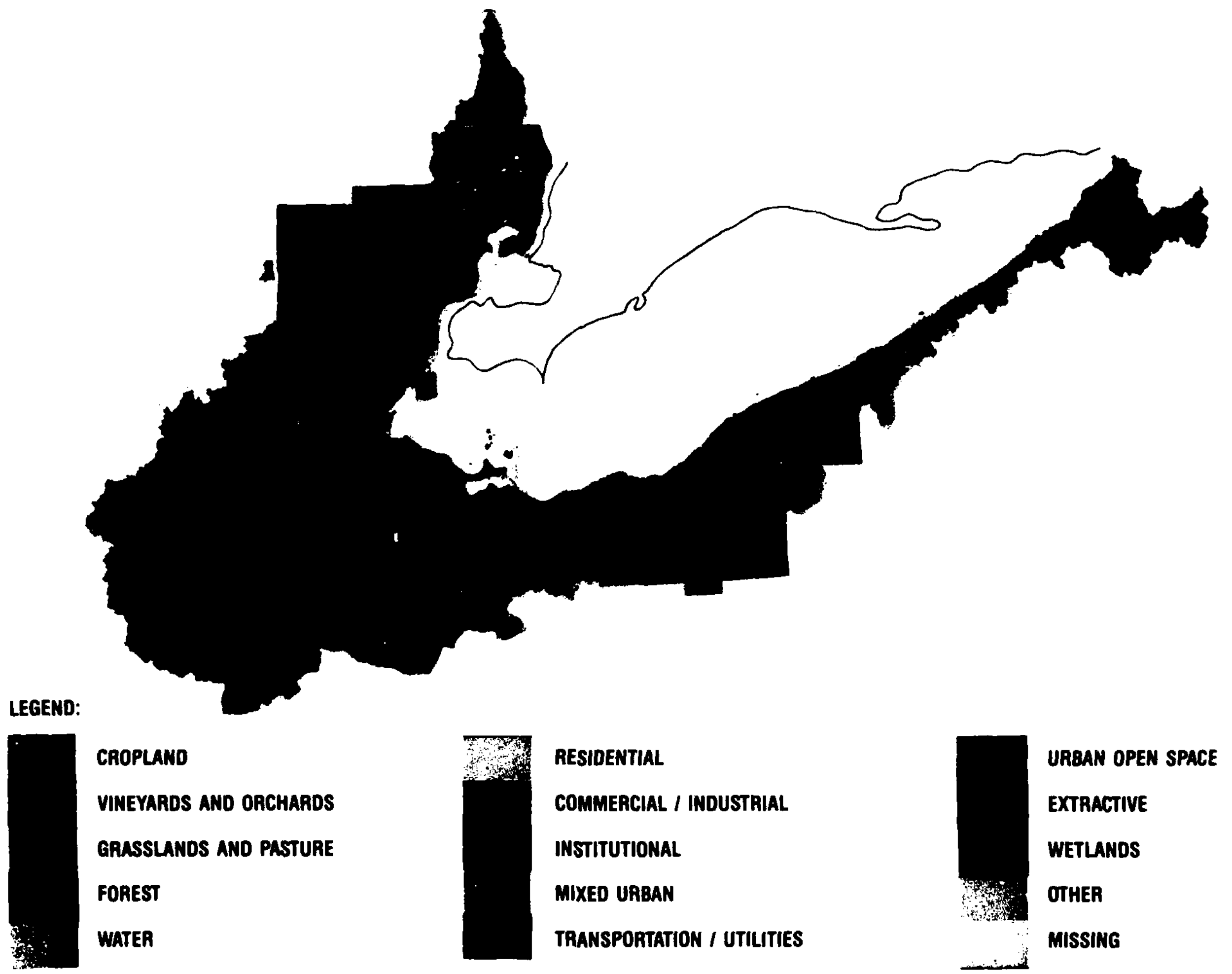


Figure 4
Lake Erie Phosphorus Loading.

MAP II
LAND USE IN THE UNITED STATES DRAINAGE OF LAKE ERIE

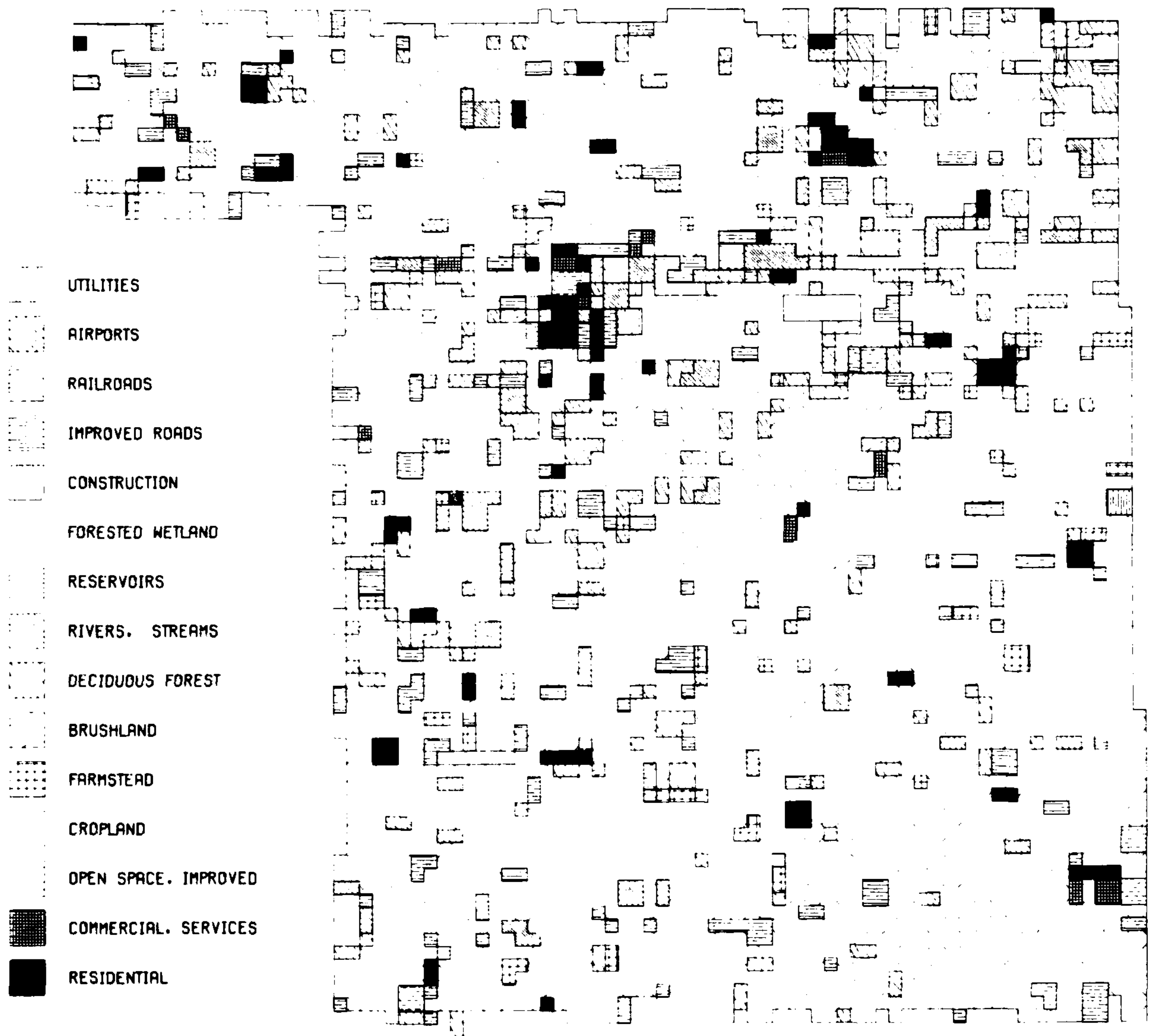


are extensively grown in the Lake Erie Basin, especially the Western Basin, are particularly susceptible to sheet and rill erosion.

The details of land form, such as slope and length of slope, and soil texture, are important variables determining the rate of erosion and the quantity of sediment produced. The frequency, duration, and intensity of precipitation events are the primary climatic factors that interact with the seasonal soil cover variations on agricultural lands to produce greater or lesser quantities of sheet and rill erosion. Winter rains on uncovered soils can produce erosion and sediment delivery far in excess of that produced during summertime periods when the soil is covered with vegetation, and infiltration is greater. Long-term (i.e., decades) observation and measurement by U.S. Department of Agriculture scientists have made it possible to calculate erosion from different soils under various cropping systems and under different climatic conditions. Using this "Universal Soil Loss Equation," LEWMS personnel were able to calculate the amount of soil erosion to be expected in the basin under existing crop and crop management systems.

In order to calculate soil losses from the many small to large watersheds or subbasins in the entire U.S. Lake Erie Basin, it was necessary to geographically inventory those factors which are used to calculate soil loss including land use and cover, soil properties, topography, climatic conditions, and crop management factors.

MAP III
LAND USE IN HENRY COUNTY, OHIO



Land Resource Information System

The large amount of data to be inventoried dictated that a computerized system be used. The computer system which was developed is known as "LRIS" or Land Resource Information System. The LRIS system includes the above encoded information for individual land tract areas varying from 10 acres to 90 acres in size. About 800,000 land tract areas were inventoried for the U.S. basin during the course of the study.

Once the land resource information system is computerized it becomes easy to generate maps, graphics, and tabularized data which is of interest and use at local levels, within subbasins, and for the entire Lake Erie Basin.

As example, Map II illustrates land use within the entire basin, while Map III is land use for Henry County, OH. Computer generated maps, graphics, and tabularized data can be generated for all 62 counties within the Lake Erie Basin as well as for all major and minor watersheds.

Examples of map outputs include:

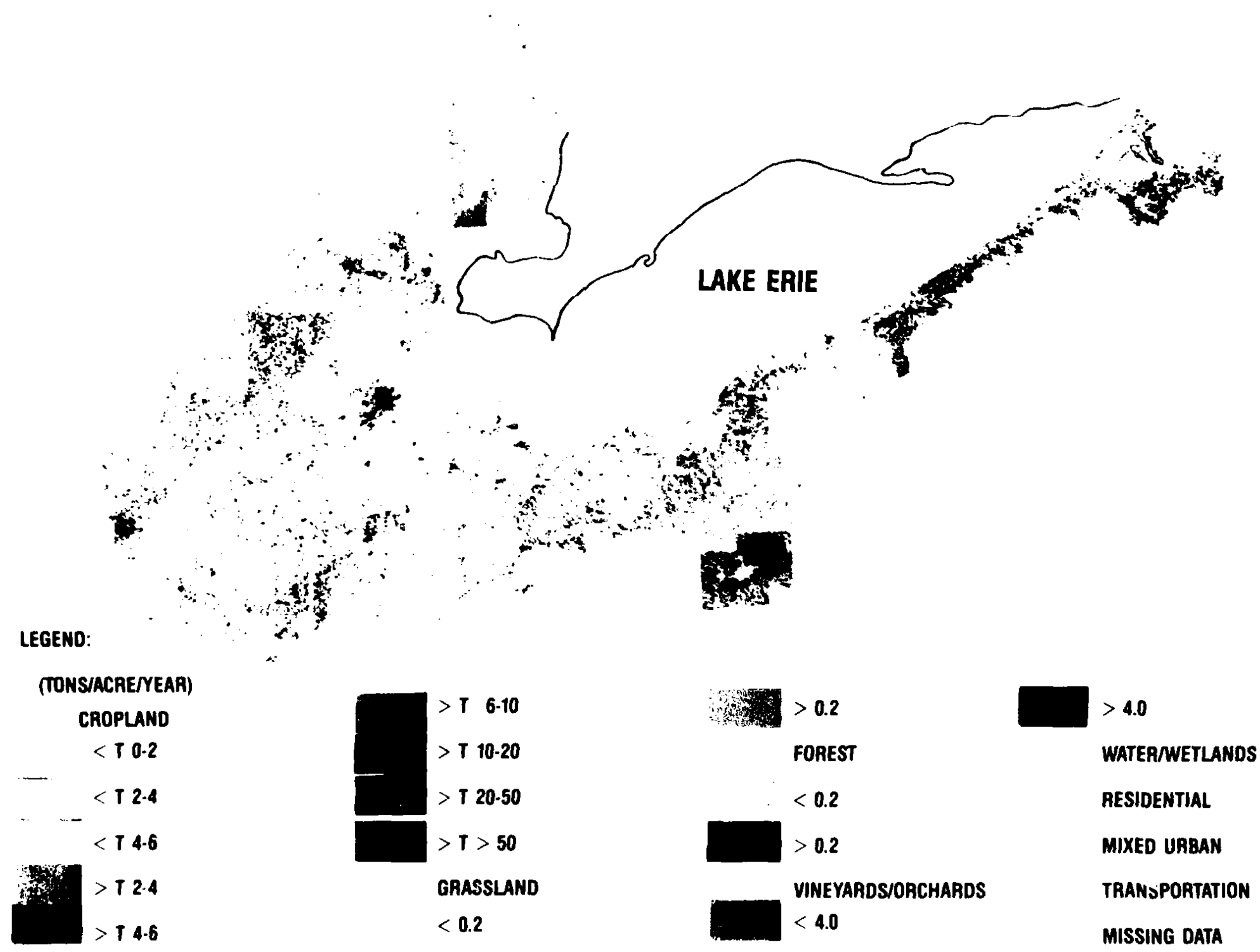
Soil Properties (surface texture, drainage, permeability, slope, erodibility)
Land Use and Land Cover
Erosion Potential
Political and Watershed Boundaries
Suitability of Land for Conservation Tillage

Soil Losses

Map IV gives estimates of gross erosion within various regions of the Lake Erie Basin. The map also shows whether the annual soil loss can be "tolerated" to maintain soil productivity (i.e., <T), or cannot be tolerated for maintaining soil productivity (i.e., >T). This map has been computer-generated by applying the Universal Soil Loss Equation to the entire basin land resource data base. Soil loss from grasslands and forested areas is predominantly less than 0.2 tons per acre. Most of the land drainage into Lake St. Clair and the Detroit River has erosion rates less than 2 tons per acre per year. Erosion rates in the very flat, ancient, glacial lake bed, generally extending southwest from the western end of the lake, are also less than 2 tons per acre per year. The greatest erosion in the basin occurs from cropland along the southwest and northwest flanks of the basin. Soil loss in these areas generally ranges from 4 to 10 tons per acre each year. Erosion maps can also be readily generated for individual watersheds and counties as may be desired. Map V is the erosion potential map for the Ottawa River Watershed in Ohio.

Not all of the soil that is eroded from the land is transported by rivers towards Lake Erie. By comparing calculated soil losses from the various watersheds to actual measurements of sediment transported in the

MAP IV
POTENTIAL GROSS EROSION IN THE UNITED STATES DRAINAGE OF LAKE ERIE



rivers, the percentages of eroded sediments transported by the streams could be calculated. Calculations indicated that the percentage of soil initially eroded from watersheds and transported by rivers varied from 6 to 12 percent. The relatively low percentages indicate that fine-grained eroded soil materials (silt and clay) relatively enriched with phosphorus are preferentially transported, as opposed to coarse-grained sands which are deposited downslope or in stream beds.

River Transport of Sediment and Phosphorus

Much of the field study during the LEWMS program was directed at determining how much of sediment and phosphorus eroded from the land eventually reaches Lake Erie via the tributary drainage system. To this end, an extensive sampling and measurement program was carried out in 78 Lake Erie watersheds from December 1974 to September 1981. The Maumee, Portage, Sandusky, and Huron Rivers were the sites of intensive study.

Most of the sediment and nutrient inputs to Lake Erie occur during runoff after rainfall. Inputs vary considerably from one storm to another, seasonally, and from year to year. Only through multiyear intensive sampling programs, as were carried out during the LEWMS study, could reliable estimates of mean annual

MAP V
EROSION POTENTIAL FOR OTTAWA RIVER WATERSHED

Symbol	Description	Percent of Watershed
	0.0-2.0 tons/acre and less than T Factor	25.1
	2.1-4.0 tons/acre and less than T Factor	5.8
	2.1-4.0 tons/acre and greater than T Factor	0.2
	6.1-10.0 tons/acre and greater than T Factor	2.0
	10.1-20.0 tons/acre and greater than T Factor	18.0
	20.1-50.0 tons/acre and greater than T Factor	1.1
	50+ tons/acre and greater than T factor	0.1

Symbol	Description	Percent of Watershed
	Grass, greater than 0.2 tons/acre	1.4
	Forest, less than 0.2 tons/acre	5.2
	Forest, greater than 0.2 tons/acre	4.6
	Urban land use	17.8
	Water and wetlands	3.7
	Undefined	14.0

TABLE 1 — Annual Variations in Transport of Sediments and Nutrients in Western Lake Erie Basin Rivers

River Station	Year	Suspended Sediment Transport 10^3MT	Total Phosphorus Transport MT	Nitrogen Transport (Nitrate-Nitrite) MT
Maumee	1975	1,329	2,748	32,000
	1976	1,588	2,739	18,000
	1977	1,233	2,256	20,000
	1978	851	2,442	27,000
Portage	1975	80	144	2,360
	1976	52	130	1,245
	1977	31	94	2,140
	1978	59	159	2,150
Sandusky, Fremont	1975	303	528	5,140
	1976	153	309	2,950
	1977	100	261	3,120
	1978	206	497	5,730
	1979	296	578	5,300
Huron	1975	86	123	1,120
	1976	62	78	617
	1977	71	111	1,346
	1978	48	117	1,210

loadings be obtained for the major Lake Erie tributaries. Table 1 shows the variability of sediment, total phosphorus, and nitrogen transported by major western basin rivers over the period 1975-1979. The location of these basins were shown in Map I. The Maumee River Basin was by far the greatest contributor of sediment and nutrients over the study timeframe.

It was of importance to ascertain how much phosphorus is associated with sediment transported in streams. From measurements on many Lake Erie tributaries, it was found that on the average 2.2 grams of phosphorus is transported with each 1,000 grams of sediment. Of this 2.2 grams, 1.6 is insoluble particulate phosphorus, while 0.6 grams or 27 percent is soluble.

It also was important to determine how much of the phosphorus transported in rivers was from point sources (i.e., Municipal treatment plants), and how much was from nonpoint sources. Point source phosphorus loadings were calculated from records available from treatment plants. The difference between total phosphorus loading as measured at river mouth stations and calculated point source loadings is the nonpoint loading. Using this methodology, it was calculated that 84 percent or more of the phosphorus discharged at river mouths to Lake Erie (Maumee, Portage, Huron, Sandusky at Fremont) is from nonpoint sources.

Using the relationships developed between flow and concentration of phosphorus for the major rivers in the Lake Erie Basin, along with Municipal treatment plant records, it was possible to calculate yearly total phosphorus loadings for point and nonpoint sources. This data is graphed in Figure 6, and shows the yearly variation. It can be seen from this Figure that point source loadings decreased from 11,900 MT per year in 1970 to about 4,500 MT per year in 1980, mainly as a result of bringing phosphorus removal technology online at large treatment plants. Nonpoint source input, which is highly related to the vagaries of weather, has varied from a low of 5,700 MT per year in 1971 to a high of 11,900 MT per year in 1977. Figure 4, given previously, represented average nonpoint source loads over the period 1970-1980, while the point source was that calculated for 1980. Atmospheric input and inflow from Lake Huron are relatively constant.

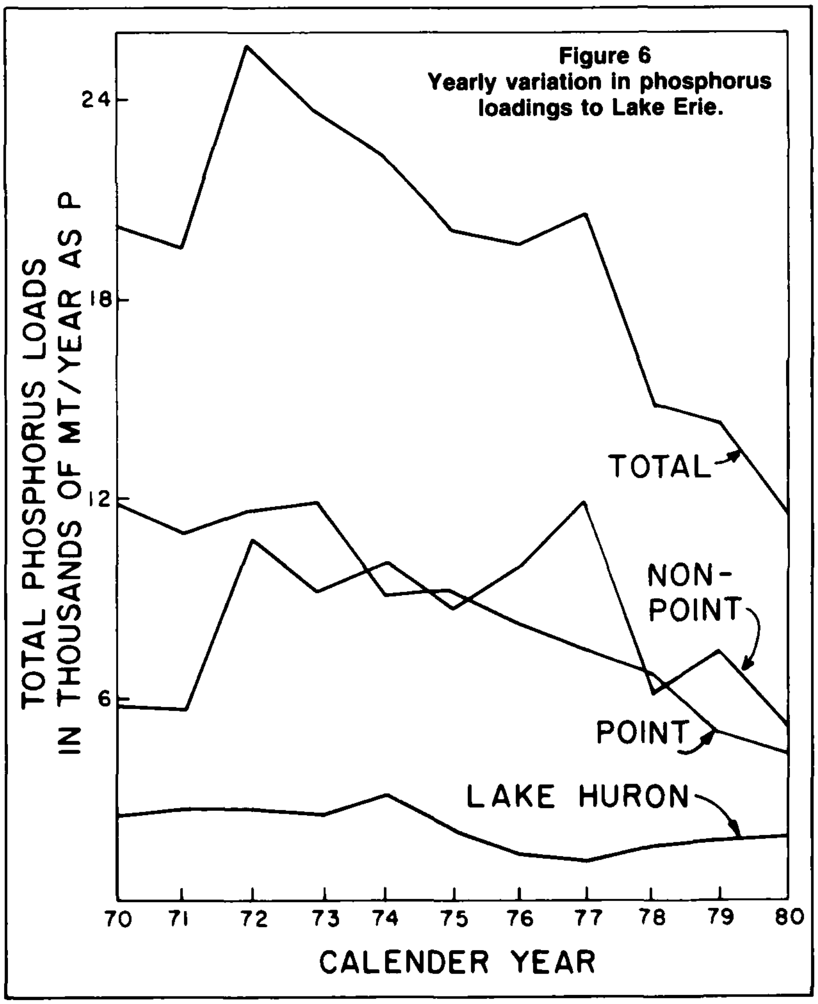


Figure 6
Yearly variation in phosphorus loadings to Lake Erie.

AVAILABILITY OF PHOSPHORUS FOR ALGAL GROWTH

Previous discussion has distinguished between point sources and nonpoint sources of phosphorus between sediment bound (insoluble) and soluble forms of phosphorus. The relative abundance and effectiveness of these various forms of phosphorus for promoting algal blooms in Lake Erie had to be assessed before an effective control strategy could be developed.

Both sediment-bound phosphorus and dissolved phosphorus are transported by streams to Lake Erie. The LEWM Study found that approximately 80 percent of the phosphorus transported by rivers in the Western and Central Basins is sediment bound and 20 percent is soluble. In the Eastern Basin, the percentage of sediment-bound phosphorus increases to about 90 percent. Soluble phorphorus is considered completely available to algae.

Numerous investigations sponsored under the LEWMS program found that the fraction of phosphorus extracted from sediments with a dilute (0.1N) sodium hydroxide (NaOH) solution was

a reliable estimate of sediment phosphorus available for algal growth. From many tests on sediment samples from the lake subbasins, it was ascertained that about 25 to 30 percent of the sediment-bound phosphorus in the Western and Central watersheds of Lake Erie can be rapidly utilized by algae. The availability of sediment phosphorus from Eastern Basin sediments was considerably less and in the order of 10 percent.

Phosphorus from Municipal treatment plants (point source) has a considerably higher availability to algae. However, it appears that treatment plant phosphorus discharged to Lake Erie tributaries is processed instream before reaching the lake and has an available fraction similar to diffuse sources upon reaching the lake.

Figure 8
No-Till Planter.

STRATEGIES FOR RESTORATION OF LAKE ERIE WATER QUALITY

Having established that a large amount of phosphorus (approximately 8,400 MT per year) entering Lake Erie each year is from rural land and the availability of this phosphorus to algae, strategies for reducing inputs of phosphorus from these sources were then focused upon. Analysis quickly showed that further removal of phosphorus from treatment plants now contributing 4,500 MT per year phosphorus to the lake to below 3,100 MT per year, would be unduly expensive (over 5.3 billion dollars was spent on Municipal wastewater treatment plants in U.S. Great Lakes drainage basin between 1971 and 1980).

Having also established that phosphorus losses from rural land occurs primarily as a result of soil erosion from cropland, attention turned to identification of agricultural land management practices which could effectively reduce soil and phosphorus runoff without imposing unacceptable practices or economic hardship on basin farmers.

Figure 7
No-Till Corn.

Conservation Tillage Practices

After assessing a variety of conservation practices for control of sediment and phosphorus losses ranging from streambank erosion control to grassed waterway and contour farming, it was concluded that conservation tillage practices constituted the most cost-effective and acceptable technology for control of soil erosion and phosphorus losses. The major objective of conservation tillage is to retain as much crop residue as possible on the land surface for the purpose of substantially reducing the erosive impact of rainfall, and greatly reducing the runoff of detached soil particles.

Conservation tillage practices consist of "reduced tillage" and "no till." Using "no till," crops are planted directly in the residue of the previous year's crop as shown in Figure 7. Special planters which cut through

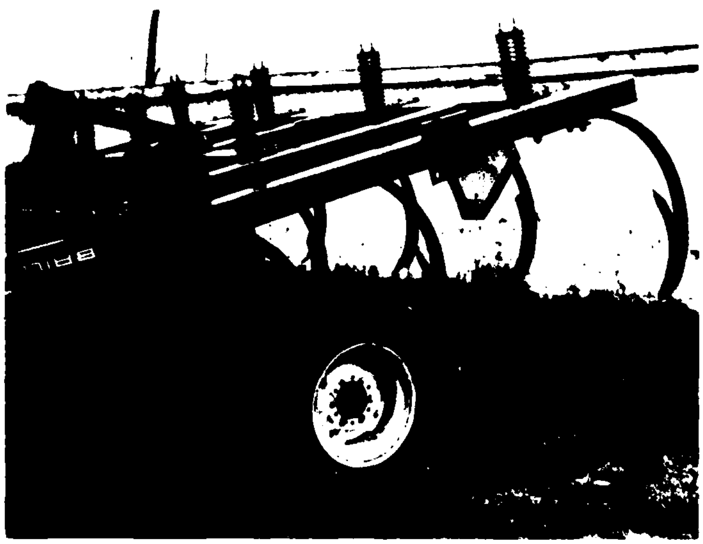


Figure 9
Chisel Plow.

the residue and place the seeds at proper depth are used. Figure 8 shows a "no till" planter. Using reduced tillage, the traditional moldboard plow is replaced by methods such as chisel plowing (Figure 9) which retains a considerable amount of crop residue on the ground surface. Investigation has shown that soil erosion can be reduced by at least 75 percent with "no till" and by 30 percent or more using reduced tillage.

Weed control using "no till" is accomplished entirely with herbicides. Using reduced tillage, a combination of herbicide application and tilling is used for weed control. Herbicide usage is expected to increase slightly with increasing adoption of conservation tillage. It is not clear to what extent the use of insecticides might increase with the adoption of conservation tillage.

Although use of pesticides is apt to increase in the basin with increasing adoption of conservation tillage, water quality is not expected to be adversely affected since control of soil runoff will also prevent runoff of pesticides.

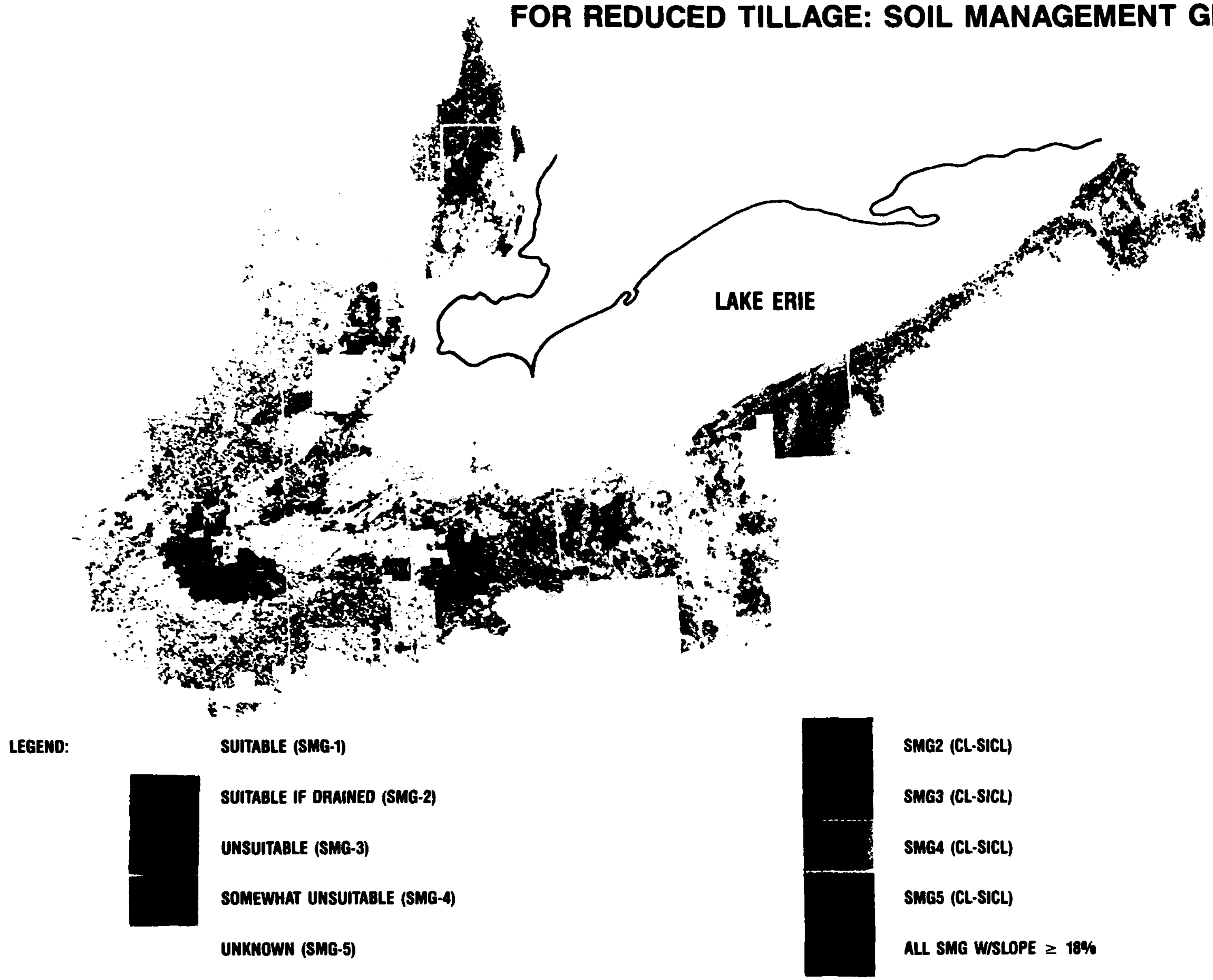
Consultation with university and U.S. Department of Agriculture crop and soil experts revealed that not all soils in the Lake Erie Basin are suitable for conservation tillage. In general, well-drained soils or soils that can be improved by tile drainage respond well to conservation tillage. Poorly drained soils, which do not respond to tile drainage, generally do not produce acceptable crop yields under conservation tillage practices. The Corps developed Land Resource Information System (LRIS), previously discussed, made it possible to inventory and map those soil areas in the basin where conservation tillage can be successfully applied. Map VI shows the general distribution of suitable and nonsuitable soils within the basin.

Computer soil data compilation shows that approximately 53 percent of U.S. basin cropland is suitable for "no till," while 80 percent is considered suitable for reduced tillage. LEWMS 1981 estimates indicate that "no till" is currently practiced on 4 percent of cropland, while reduced tillage is practiced on 22 percent of basin cropland. Thus, the opportunity for expansion of conservation tillage is large, especially in the Western Basin of Lake Erie where the combination of suitable soils and intensive row cropping is most prevalent. The most commonly grown row crops in the basin which are amenable to conservation tillage are corn and soybeans.

Achievable Reductions in Soil Erosion and Phosphorus Losses

By applying the Universal Soil Loss computation to the land resource information system data base, it was possible to calculate potential soil erosion in the entire Lake Erie Basin, and within the subbasins. Table 2 shows the results of these computations for the existing array of cropping and conservation practices in

MAP VI
SUITABILITY OF SOILS IN THE UNITED STATES DRAINAGE OF LAKE ERIE FOR REDUCED TILLAGE: SOIL MANAGEMENT GROUPS



the basin, and the erosion rates which would be expected if conservation tillage practices were instituted on suitable cropland. As seen from this table, the potential erosion from the entire U.S. basin was 25 million tons per year with about 66 percent of that erosion in the Western Basin.

If reduced tillage practices were employed on all suitable cropland soils in the basin, erosion potential would be reduced by 46 percent with 50 and 42 percent reductions in the western and central basins, respectively. If "no till" was applied to all suitable cropland basin soils along with reduced tillage to the remainder of the cropland suitable for conservation tillage, the overall soil erosion reduction would be 69 percent with 73 and 64 percent reductions in the western and central basins, respectively. The eastern basin is expected to benefit less, but significantly from conservation tillage because a large percentage of the land is in forest or permanent grassland.

The numbers contained in Table 2 assumed 100 percent adoption of conservation tillage practices on suitable cropland and, therefore, represent maximum reductions which could occur. Realistic estimates of reductions in soil losses have been made based on projected increases in adoption of conservation tillage. Projections have been made for two different conditions. The first assumes that the adoption of conservation tillage will increase at rates experienced under existing programs as shown in Figures 10 and 11. The second set of adoption curves shown in these Figures assumes that an "accelerated" conservation tillage program, to be described later in this report, will be implemented in the Lake Erie Basin. Under an accelerated program, it is expected that by approximately the year 2002, 46 percent of basin cropland will have reduced tillage practices, and 30 percent will have "no till" practices. Thus, 76 percent of the basin could have conservation tillage practices by the year 2002 under the proposed accelerated program.

Under the accelerated program, soil erosion in the basin will be reduced 48 percent. Figure 12 illustrates reductions in soil erosion which may be achieved with existing and accelerated programs.

What reductions in phosphorus loadings to Lake Erie can be achieved by implementation of an accelerated conservation tillage program? Given the erosion reductions of the previous paragraph, it is calculated that a 32 percent reduction in phosphorus loadings to Lake Erie can be achieved over a 20-year period, with 90 percent of this reduction occurring in the first 7 years. Approximately 33,000 metric tons of phosphorus will be retained on the land over this period. Existing programs will only achieve a 15 percent Lake Erie phosphorus loading reduction over the same time period. Figure 13 compares projected phosphorus loading reductions achievable under existing and accelerated conservation tillage programs.

TABLE 2 — Existing and Potential Achievable Reduction of Soil Erosion in the United States Lake Erie Drainage Basin

(million tons per year)

Conservation Practices	Western Basin	Central Basin	Eastern Basin	Total Lake Erie Basin
Base Year (1975)	16.6	6.7	1.8	25.1
Reduced Tillage	8.3	3.9	1.3	13.5
Only (percent reduction)	(50)	(42)	(28)	(46)
No-Till and	4.5	2.4	0.9	7.8
Reduced Tillage (percent reduction)	(73)	(64)	(50)	(69)

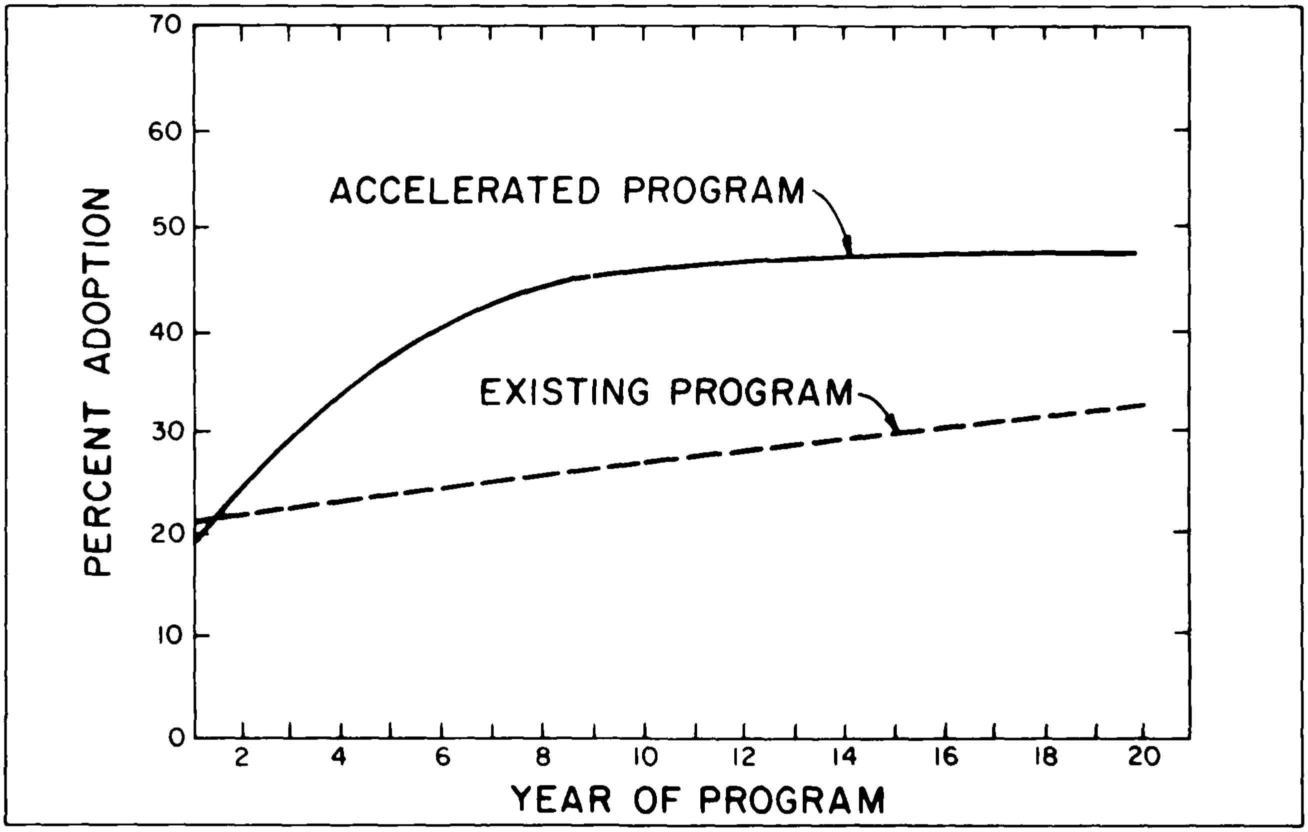


Figure 10 Projected Rate of Reduced Tillage Adoption.

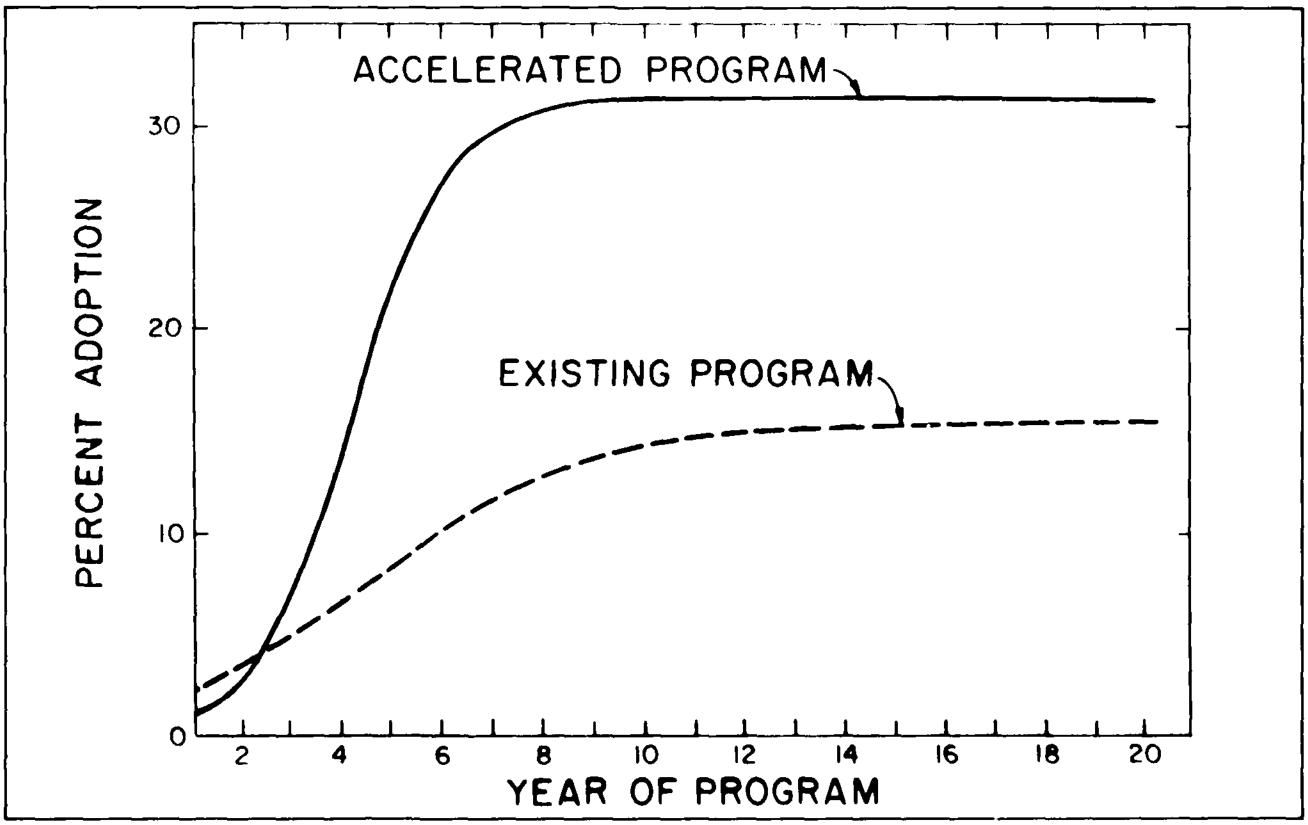


Figure 11 Projected Rate of No-Tillage Adoption.

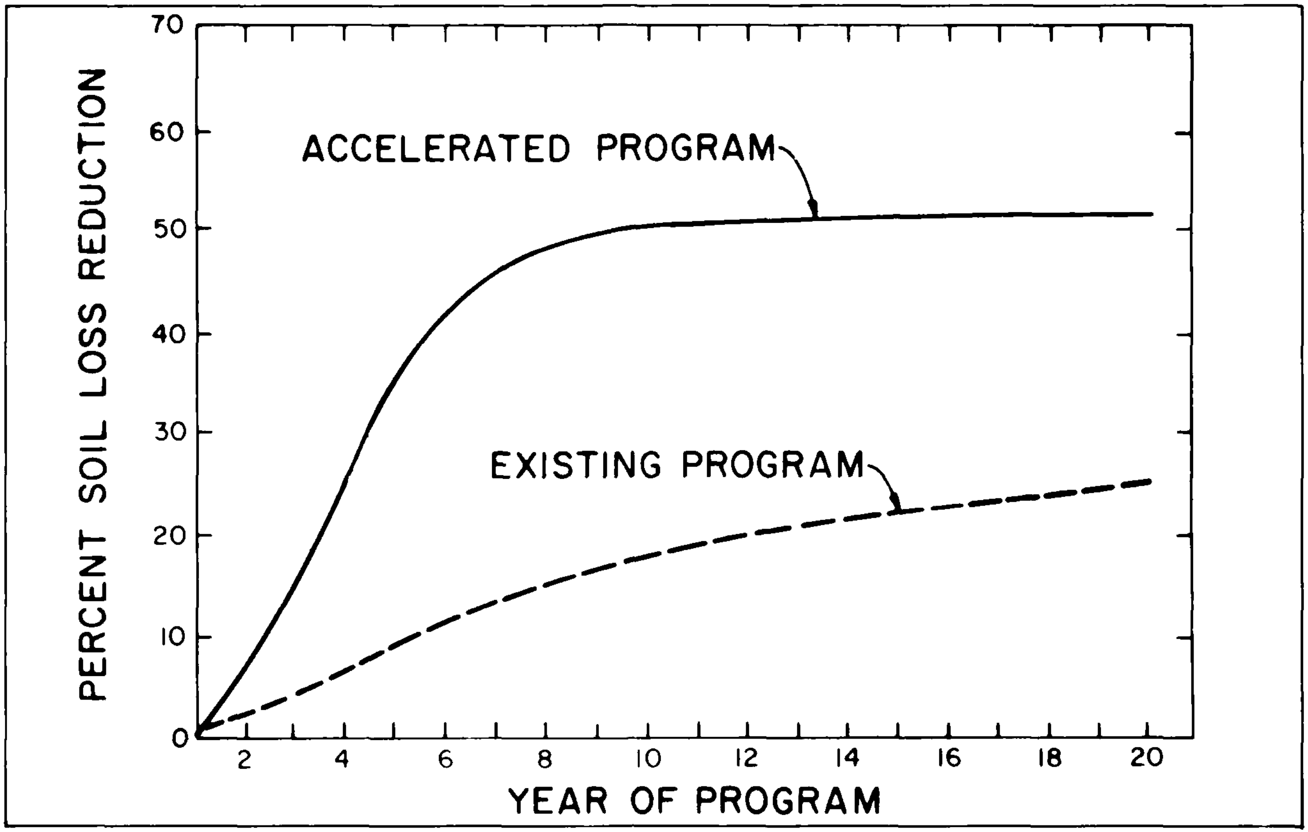


Figure 12 Soil Loss Reductions Achievable Under Existing and Accelerated Conservation Tillage Programs

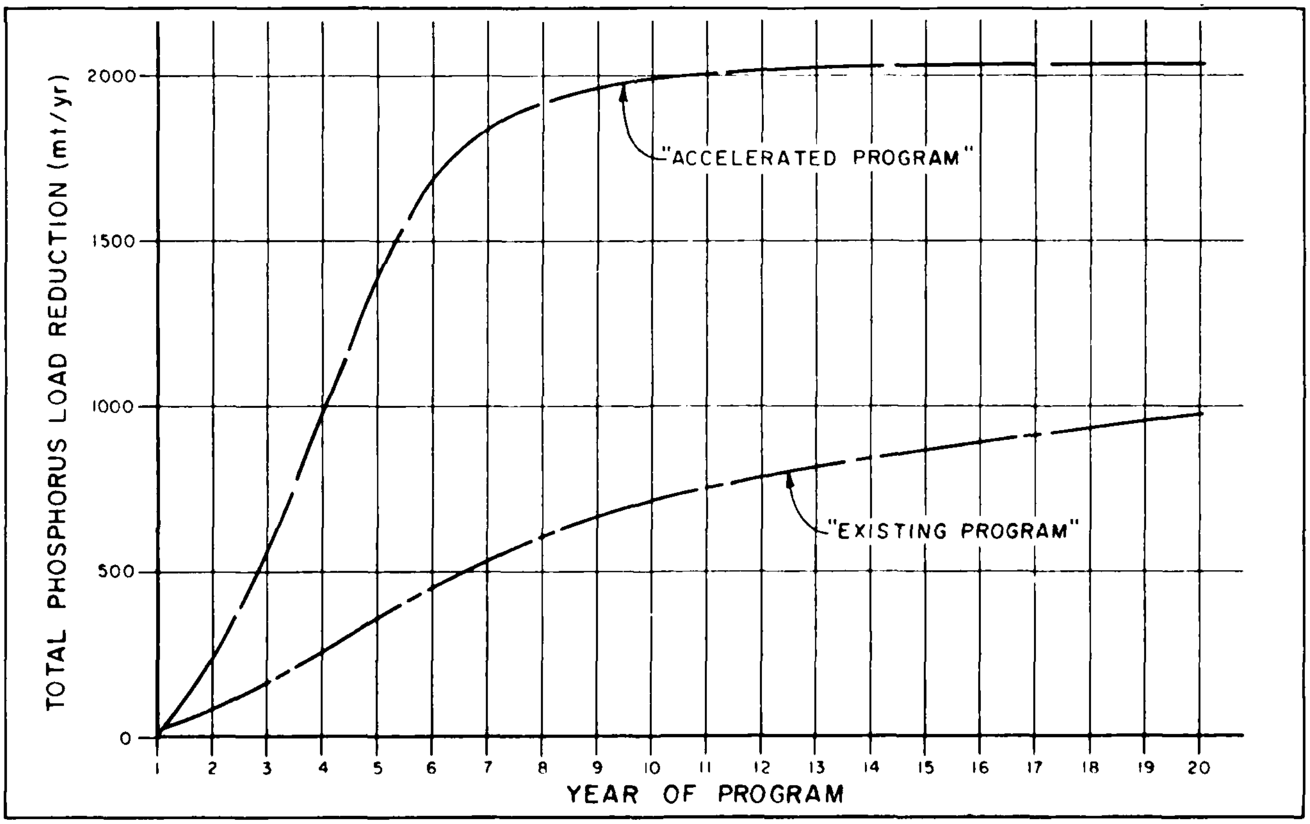


Figure 13 Diffuse Source Total Phosphorus Load Reductions.

Fertility Management

Many farmers in the Lake Erie Basin apply fertilizer phosphorus to cropland to increase plant available phosphorus levels. A relatively high percentage of this applied phosphorus can occur as dissolved phosphorus runoff which cannot be controlled through conservation tillage practices. Investigation during the LEWMS program found that plant available phosphorus levels in Michigan and Ohio soils have been increasing steadily to the point that they are generally in excess of levels necessary for optimum crop production.

The proposed accelerated conservation tillage program would promote the use of annual soil tests to insure that phosphorus is not applied in excess of crop needs, thereby reducing soluble bioavailable phosphorus runoff. In addition, farmers could reduce fertilizer costs.

Other Conservation Practices

A number of other management practices were considered and evaluated for control of phosphorus from rural nonpoint sources. The costs of implementing these practices for each kilogram of biologically available phosphorus prevented from reaching basin rivers were estimated and are shown in Table 3. Since the adoption of conservation tillage practices by the individual farmer supplants existing practices with no reductions in yield, loss of production (i.e., land out of production), or net added cost to the farmer, a zero cost can be assumed.

With the exceptions of barnyard runoff control, manure storage and processing,and fertility management, other conservation practices, while serving to control erosion on critical areas or points, are very expensive per kilogram of phosphorus kept on the land, and not cost effective for phosphorus control.

TABLE 3
Costs of Methods for Reducing Phosphorus Runoff

Method	Total Phosphorus $/kg	Percent Biologically Available Phosphorus	$/kg of Biologically Available Phosphorus
RURAL NON-POINT SOURCES			
No Till and Conservation Tillage	0	25	0
Cover Crops	276.00	25	1,10.00
Critical Area Seeding	326.00	25	1,300.00
Coutour Stripcropping	82.00	25	330.00
Diversions	2,640.00	25	10,600.00
Waterways	97.00	25	390.00
Vegetative Filters	30.00	25	120.00
Runoff Control Structures	368.00	25	1,470.00
Terraces	73.00	25	290.00
Tile Drains	9,180.00	25	36,720.00
Manure Storage and Spreading	4.40	75	5.90-36.3
Barnyard Runoff Control	2.20	75	2.90
Fertility Management	0	25	0
Fertilizer Placement	44.00	25	176.00

WATERSHED MANAGEMENT STUDIES

The strategies prescribed previously for restoration of Lake Erie water quality were arrived at after much consideration of available alternatives. A decision was made to exercise this strategy on a pilot basis in selected watersheds and counties within the Lake Erie Basin.

Honey Creek Project

A special demonstration project, **The Honey Creek Watershed Management Program** (HCWMP), was initiated in 1978 as part of LEWMS. The location of this 120,000-acre watershed is shown in Map VII. Through contracts with a Joint Board of Supervisors of Huron, Crawford, and Seneca SWCD's of Ohio, funds were provided for technical assistance manpower, education programs, and application of conservation tillage and other management practices. Objectives were to demonstrate that the local agricultural agencies and Soil and Water Conservation District's (SWCD's) working with individual farmers could bring about changes in agricultural land management practices. Major thrusts were directed towards conservation tillage with increased one-to-one technical assistance and demonstration plots. A comprehensive inventory of needed management practices and identification of priority critical areas for the watershed was completed. Two water monitoring stations were established and are being maintained.

Estimates of reductions in soil erosion and phosphorus losses from the study area were made to provide guidance on what benefits may be realized from instituting conservation tillage. Estimates were made for 10-20 acre demonstration plots using the Universal Soil Loss Equation. Calculations showed that reduced tillage systems decreased erosion rates from 6-7 tons per acre per year (T/ac/Yr) to 4-5 T/ac/Yr, or by about 30 percent

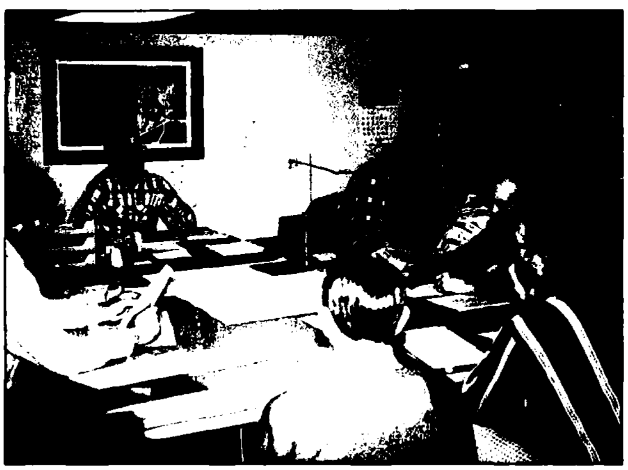


Figure 14
Farmer Meetings on Conservation Tillage

Figure 15
Conservation Tillage Demonstration

over the conventional plow systems. On the same soils, but often different fields, "no till" decreased erosion rates from 6-7 T/ac/Yr to 1-2 T/ac/Yr, or about 75 percent.

Reduced tillage systems in the Honey Creek Watershed would potentially decrease phosphorus transport by 26 percent. No-till would decrease phosphorus transport by 64 percent. Impact of the conservation tillage program on crop yield and farmer net income is described in the next section.

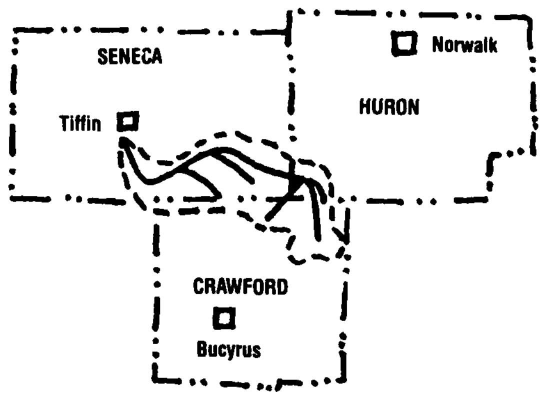
The Honey Creek Watershed Management Program demonstrated that local agricultural agencies (Soil Conservation Service, Agricultural Extension Service) and Soil and Water Conservation Districts, working with individual farmers (Figures 14 and 15) could bring about positive changes in agricultural management practices. Conservation tillage in the Honey Creek Watershed counties increased from 2,400 acres in 1979 to 16,200 acres in 1981, 13,000 acres of which was attributed to spin-off from the demonstration program. The HCWMP has been used extensively as a showcase and model.

Five Watershed Studies

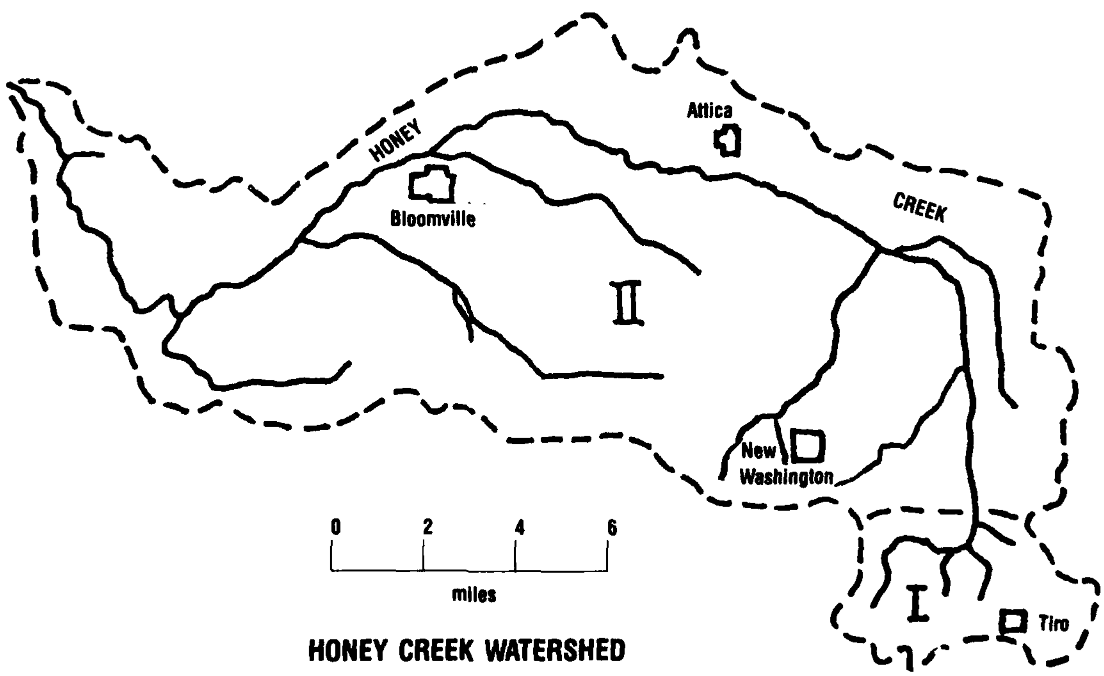
Five additional studies were undertaken as a part of LEWMS. The studies were scattered throughout the Lake Erie Basin to look at different critical land forms, land uses, soils, and geographic areas. These watersheds were selected to represent various conditions in the basin. The five basins, as shown in Map VIII, are: the South Branch of Cattaraugus Creek (NY); West Branch Rocky River (OH); Bean Creek (MI); Ottawa River (OH); and the Sandusky River (OH). The studies involved local agricultural agencies and agricultural interest groups in the study process. Each study included baseline water quality monitoring, identification of major problems, needed practices for watershed treatment, and proposed implementation work programs. Educational programs, technical assistance and administration, estimates of costs and proposed im-

MAP VII
HONEY CREEK WATERSHED AS LOCATED IN SENECA, CRAWFORD AND HURON COUNTIES IN OHIO

LOCATION IN OHIO

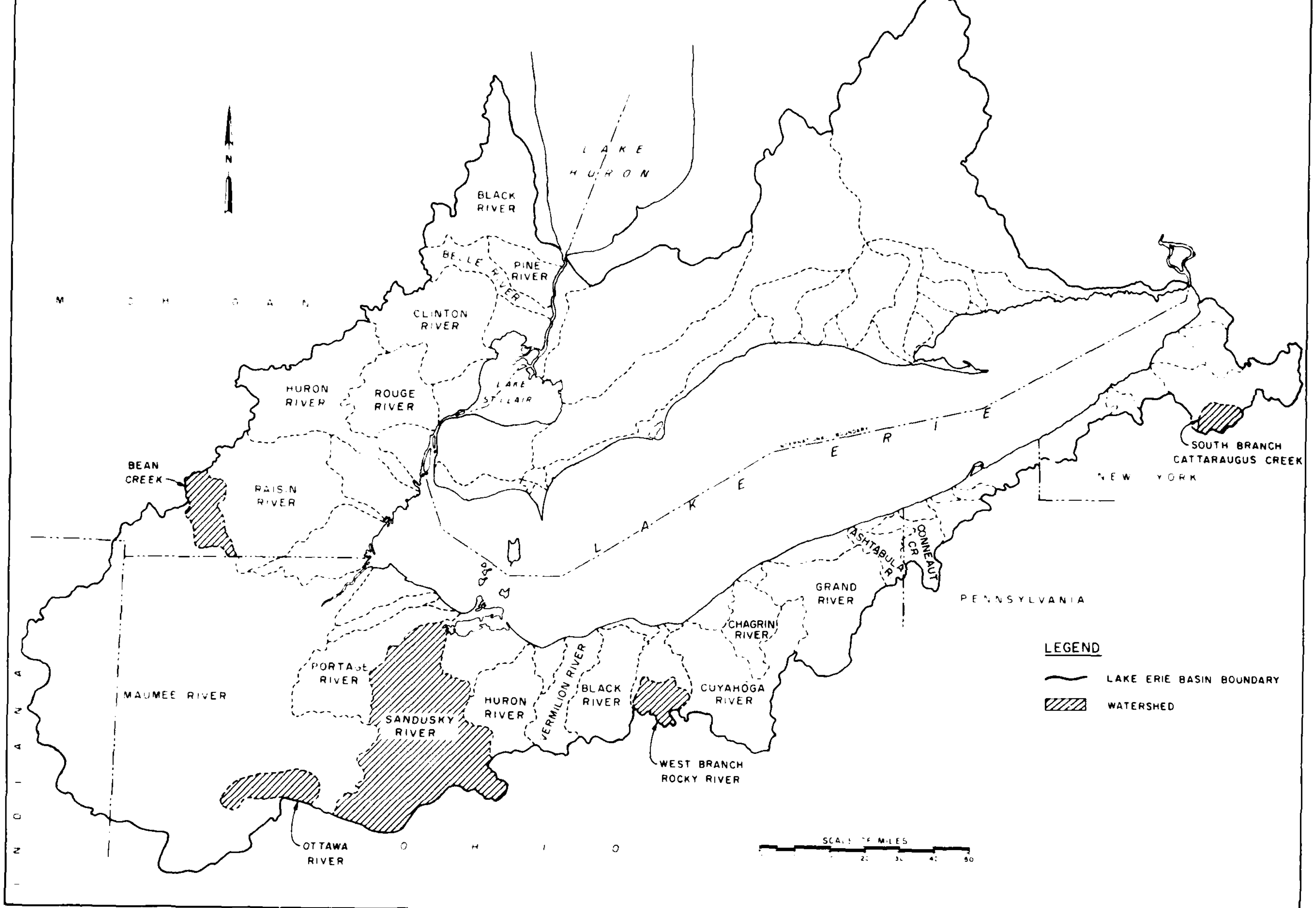


RELATION TO COUNTIES AND COUNTY SEATS



HONEY CREEK WATERSHED

MAP VIII
FIVE WATERSHED STUDY LOCATIONS



MAP IX
COUNTIES WITH COMPLETED CRISP REPORTS

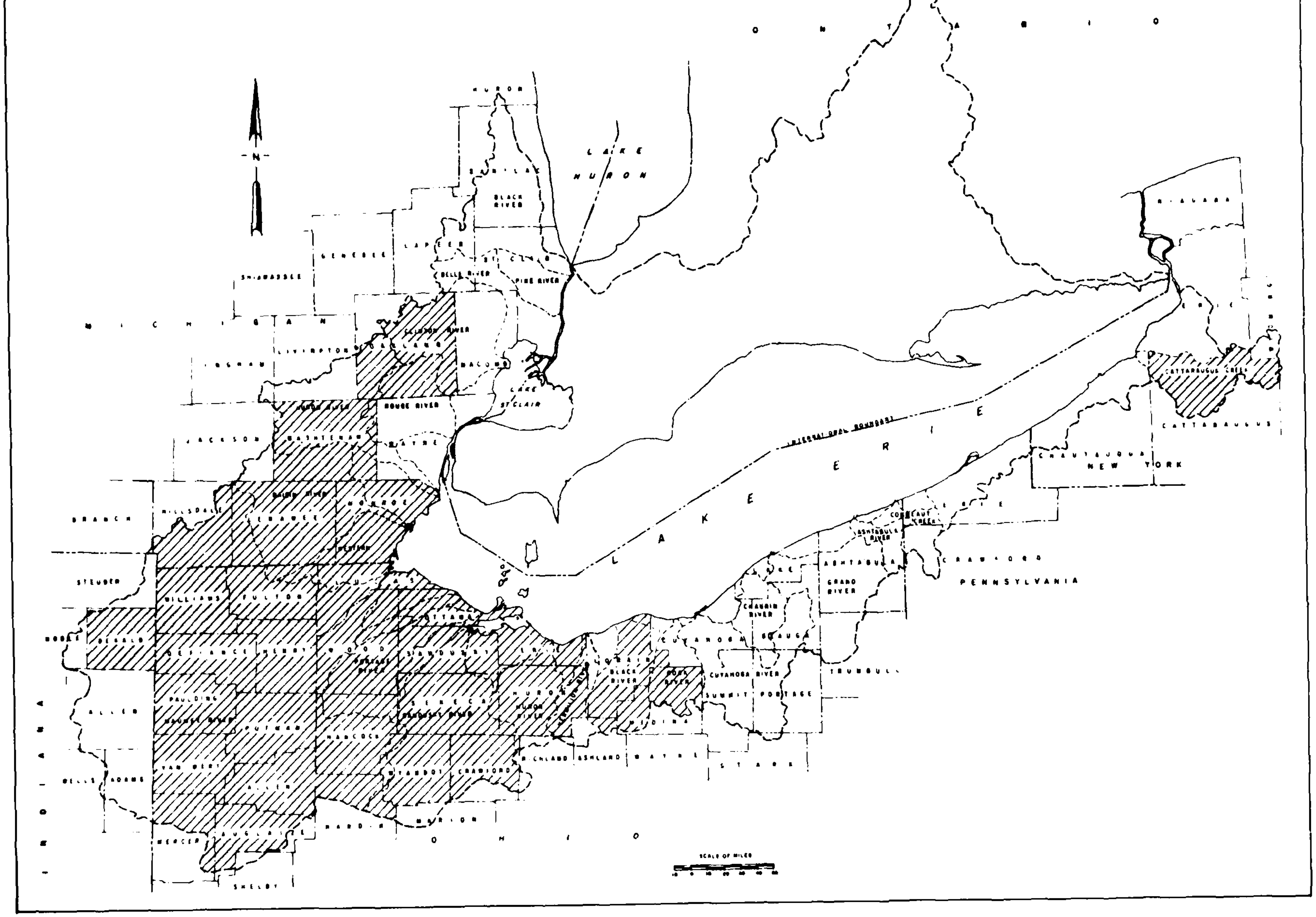


TABLE 4 — Average Percent Reductions in Cropland Potential Gross Erosion Using Conservation Tillage for Five Watershed Studies

Watershed	PGE (T/Ac/Yr)	Reduced Tillage Percent Reduction	Maximum Reduction Tillage Percent Reduction
Sandusky (OH)	4.2	50 (45) (1)	80 (72)
West Branch Rocky River (OH)	5.4	37 (33)	61 (55)
Bean Creek (OH)	7.7	53 (48)	81 (73)
Ottawa River (OH)	5.3	59 (53)	85 (77)
South Branch Cattaraugus Creek (NY)	7.9	39 (35)	54 (49)

(1) Estimates of phosphorus reductions are shown in parentheses.

plementation schedules are a part of each report. Major overall objectives were:

a. To identify and document critical problems within the selected watersheds.
b. To establish and/or continue baseline water quality monitoring for evaluating benefits of future implementation programs.
c. To inform and involve local people in the watershed management study activities.
d. To develop model education and technical assistance management programs for each watershed.
e. To prepare watershed management study plans for future demonstration and implementation programs.

These five watershed management studies present programs which will control diffuse (nonpoint) sources of pollution and phosphorus. They are consistent with and complimentary to ongoing water quality planning efforts under Section 208 of the Clean Water Act. Watershed problems, treatment needs, and alternative land management solutions are identified. Estimates of the achievable reductions in soil erosion and phosphorus losses for each of the five watersheds are given in Table 4.

Much of the information concerning the five watershed studies is based on the Lake Erie Wastewater Management Study's Land Resource Information System, previously described. The computerized LRIS watershed maps, reduced for inclusion in these reports, are available in their original (1/48,000) size from the Buffalo District, Water Quality Section.

County Resource Information System Packages

The County Resource Information System Packages (CRISPS) are compendia of information derived from the Lake Erie Wastewater Management Study's Land Resources Information System. They consist of maps and tabular information summaries for 28 counties in the U.S. portion of the Lake Erie drainage basin. Map IX shows counties for which CRISP packages have been prepared.

One principal function of the CRISP'S is to provide resource information. In both the maps and tables, data on land use, watershed boundaries and areas, political boundaries and areas, soil physical properties, and erosion areas are presented.

A second function of the CRISP'S is to suggest possible alternative land management practices for areas where there may be soil erosion problems. "Best Management Practices" maps have been prepared by evaluating land resource characteristics to suggest practices which would reduce soil erosion. The resource base has also been examined to suggest potential sites for land disposal of municipal sewage, effluents, and sludges.

These comprehensive information packages will serve as invaluable tools to assist county Soil and Water Conservation Districts and others in the long-term implementation of controls on diffuse source sediment, phosphorus and ultimately other nutrients and/or pollutants from agricultural land.

ECONOMIC IMPACTS OF CONSERVATION TILLAGE

Highly significant reductions in soil erosion and phosphorus losses may be realized by implementation of conservation tillage practices. However, individual farmers cannot provide these overall societal benefits if their net returns are adversely affected.

Impact on Crop Yields

One of the most important factors to be considered is the impact of alternative tillage systems on crop yields. Extensive data were gathered from farmers during the LEWMS program to determine actual on-farm yields from alternative tillage systems. These data were acquired through numerous demonstration plots as farmer surveys.

Conservation tillage demonstration plots were established in a number of Western Ohio counties including Crawford, Huron, Seneca, Allen, Defiance, Fulton, Henry, Paulding, and Williams. In general, it was found that yields of corn and soybeans from reduced tillage plots were about the same as yields from conventionally tilled plots. Yields from no-till plots often were not as great as corn yields from conventionally tilled plots and could be attributed to poor soil drainage or problems with fertilizer placement. No-till soybean yields were greater than yields from conventional plot.

Researchers from the Ohio State University conducted a survey of 96 farmers in the Western Lake Erie Basin. The results showed that surveyed farmers in the basin were obtaining as good or better corn yields from reduced or "no till" as with conventional plowing and tillage.

It may be concluded that corn and soybean yields in the basin using reduced tillage or no-till should be comparable to yields using conventional tillage. However, attention must be placed on proper field selection (i.e., good drainage) and careful management practices (i.e., fertilizer selection, proper weed control, use of rotations) to obtain comparable yields with no-till.

Impact on Crop Production Costs

Ohio State researchers gathered extensive data on material, labor, and other costs associated with crop production using conservation tillage. They concluded that reduced tillage reduces equipment and labor costs about 8 percent. About 10 percent less equipment and labor costs may be realized using no-till compared to conventional tillage. Herbicide use and costs increased with both reduced and no-till, while insecticide use and costs generally increased with no-till.

Similar results were found from analysis of production cost data from the LEWMS Honey Creek Watershed demonstration plots. In summary, increased material costs for no-till crops were more than offset by reduced machinery costs when compared to conventional tillage systems. Additional savings occurred in reduced tillage systems where both material and machinery costs tend to be lower.

Impact on Net Farm Income

The ultimate indicator of the economic viability of new farming systems is the net return to individual farmers in the basin. During the LEWMS program, careful attention was given to ascertaining the economic impact of conservation tillage to the farmer. This effort consisted of determination of net returns for demonstration plots, development of a predictive model for basin-wide impact, and farmer surveys.

Over the 3-year Honey Creek project, net returns for corn plots were highest under conventional tillage; while for soybeans, the highest net returns were achieved by the no-till plots.

The economic net-return model developed at Ohio State used soils information, expected crop yield data, estimated crop production costs, and projected commodity prices to predict net farm income for the entire basin using conventional and conservation tillage technology. The model predicts relatively little impact of conservation tillage on basin farm net income with 0-3 percent increases if conservation tillage were employed on suitable cropland soils. If no-till or reduced tillage were employed on unsuitable soils, basin net income could be reduced according to the model. The model also indicates that Western Basin counties could realize greater net farm income benefits from conservation tillage than Eastern Basin counties.

The Ohio State survey of 96 farmers in the basin showed that net returns were nearly the same for all tillage systems. Considering the overall results of the various investigations under the LEWMS program in addition to the established research findings of State agricultural colleges, it is concluded that the widespread adoption of conservation tillage should not result in reduced net income to farmers within the Lake Erie Basin.

PROGRAM AND AGENCY COORDINATION

Public Law 92-500 (Federal Water Pollution Control Act Amendments of 1972) which authorized the Corps of Engineers Lake Erie Wastewater Management Study stated that the study was to be, in addition to other studies, aimed at eliminating pollution from sources around Lake Erie. A number of programs are complementary to this study. These include the Pollution from Land Use Activities Reference Group (PLUARG) studies initiated by the International Joint Commission in 1972, Section 208 studies authorized by Public Law 92-500 as amended by Section 35 of the Clean Water Act of 1977, and Section 108(a) projects authorized by Public Law 92-500.

The Lake Erie study involved extensive coordination with groups at local, State and Federal levels of Government. At the grass roots level, the cooperation and efforts of local Soil Conservation Districts (SCD) or Soil and Water Conservation Districts (SWCD's) was most effective in explaining the merits of conservation tillage to the local farmers and encouraging their participation. Since the numerous watershed programs included more than one county, individual SCD's or SWCD's formed ad hoc joint boards for the special purpose of promoting program goals.

In April 1981, the Regional Administrator of USEPA Region V, the Chief of Soil Conservation Service and the Division Engineer, North Central signed a position paper on the Great Lakes. Its purpose was to establish a framework for the coordination of the activities of the agencies in the Great Lakes Basin. The focus of this coordination is to foster accelerated implementation of agricultural nonpoint source pollution control programs where nonpoint sources preclude the achievement of the target goals contained in the Great Lakes Water Quality agreement of 1978.

Numerous USDA agencies provided valuable technical, educational and promotional assistance, and worked closely with the Corps of Engineers to develop the watershed management programs for the five watershed study areas. The Soil Conservation Service provided soils and land use inventory data, soil erosion data, and erosion control data. The Agricultural Stabilization and Conservation Service (ASCS) provided information on crop acreages and yields, and provided Agricultural Conservation Program (ACP) funds for inducing individual farmers to participate in early demonstration programs (i.e., allotments for acreage in conservation tillage).

The Cooperative Extension Service (CES) offices provided needed educational assistance to inform farm organizations and individual farmers of the technical details of conservation tillage practices, and the benefits and potential problems associated with conservation tillage. Researchers from Land Grant Universities provided agronomic and economic information and assisted LEWMS staff in designing and implementing the study.

Coordination between the Federal/State agencies and the Corps was facilitated through the formation of an "Interagency Technical Advisory Group" (ITAG) which met once or twice each year to clearly establish direction of the LEWMS and the participatory roles of each agency in meeting objectives and goals of the study. Members of ITAG kept the LEWMS staff informed on current policies of Government or agencies which they represented.

Important coordination and joint effort with USEPA was carried out through the Great Lakes National Program Office (GLNPO). Under Section 108(a) of the Clean Water Act, EPA funded no-till demonstration programs in 22 counties in Ohio, six counties in Indiana, and two counties in Michigan. The Corps has made the land resources inventory data acquired during the LEWMS study available to the local agencies.

The Corps of Engineers County Resource Information System Packages previously described, have been provided as planning aids to 28 local agencies including SCS offices, SCD's, SWCD's, ASC offices, and regional planning and development organizations.

The staff of LEWMS served on several work groups concerned with controlling diffuse sources of phosphorus. These groups were: (1) Task Group III, a technical group to review phosphorus loadings for the Fifth Year Review of Canada-United States Great Lakes Water Quality Agreement; (2) Phosphorus Management Strategies Task Force under the Research Advisory Board of the International Joint Commission; (3) Technical Advisory Group for Task C, River Basin Studies; under the Pollution from Land Use Activities Reference Group (PLUARG) of the IJC; (4) Nonpoint Source Work Group for the Fifth Year Review of Canada-United States Great Lakes Water Quality Agreement; (5) Public Consultation Panel for PLUARG; (6) State of Ohio's Undesignated Area 208 Technical Advisory Committee; (7) the Great Lakes Basin Commission's work group on coordination of Areawide Water Quality Management Planning activities with Great Lakes water quality objectives; (8) the Nonpoint Source Control Task Force under the Water Quality Board of IJC.

PROPOSED PROGRAM FOR RESTORATION OF LAKE ERIE WATER QUALITY

The proposed program for reduction of sediment phosphorus loadings to Lake Erie is a locally oriented demonstration/implementation program focusing on conservation tillage and fertility management. Reducing the amount of tillage done on basin farms has proven to be the most cost-effective means of controlling erosion and sediment phosphorus transport, both from the standpoints of farm operators and governmental agencies. This type of program is recommended for 20 counties selected from Land Resource Information System data as having highest priority for treatment. Each county will receive provisional funding for 5 years, and it is expected that all counties will have completed their projects within 10 years of initial funding for the first counties participating.

Selected Counties

Twenty counties have been selected to receive project funding under the proposed program. The criteria used to select the counties was the number of acres in the county on which conservation tillage is projected to be adopted, the reduction in soil loss which could be achieved, and a factor weighting the potential of the county for phosphorus transport. These counties are shown on Map X. Five additional counties are also listed. These counties could replace those counties on the original list where programs could not be developed, or where compatible programs are already in place.

Selection of these 20 counties effectively encompasses the areas of the Maumee and Sandusky River Basins characterized by soils most easily adapted to conservation tillage. Acceptance of conservation tillage practices should be high in these counties, as will be the reductions in sediment phosphorus transported from them.

Program Management

A conceptual organization for management of the basin conservation tillage program is shown in Figure 16. As shown in Figure 16, an agency must assume overall management and coordination of the 20-county program. Soil and Water Conservation Districts appear most logical for administration of personnel and funds at the county level.

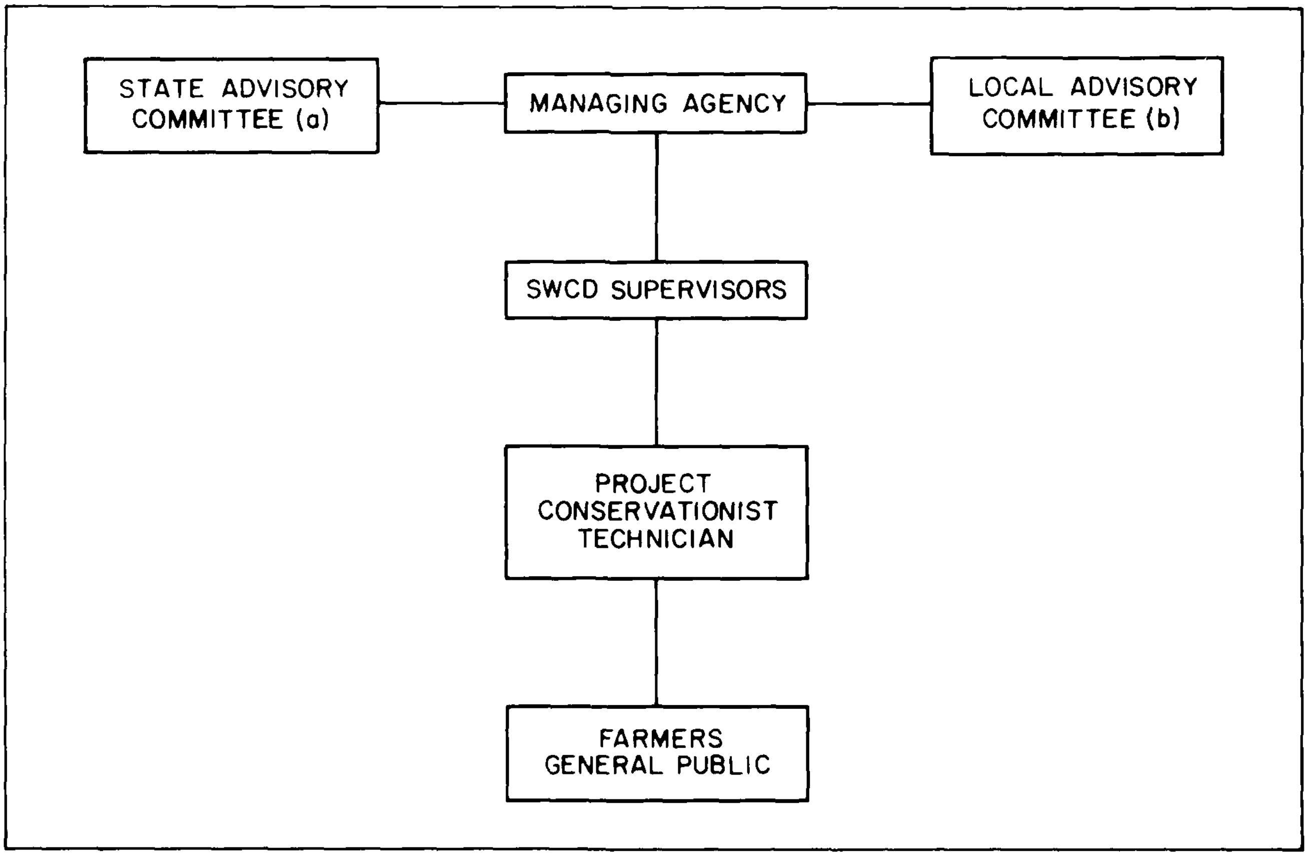
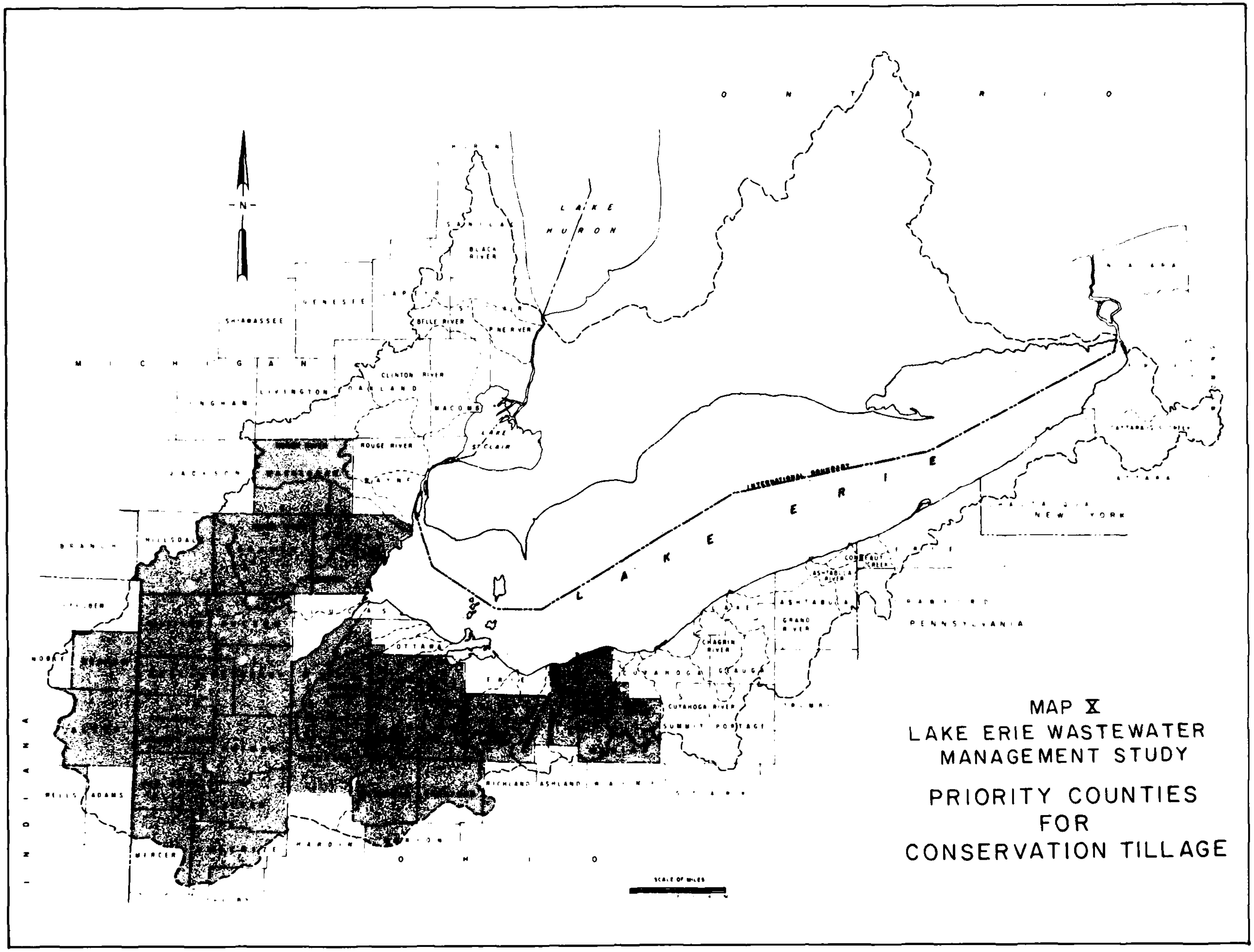


Figure 16
Lake Erie Basin Conservation Tillage Program Organization



MAP X
LAKE ERIE WASTEWATER
MANAGEMENT STUDY

PRIORITY COUNTIES
FOR
CONSERVATION TILLAGE

The advantages of contracting directly with local districts include already established program priorities in the area of soil erosion control. Routing funds from the managing agency directly to local districts would eliminate many problems. One major reason for the success of the Honey Creek project was that the local Supervisors were responsible for the success of the program.

Program Staffing

The major staffing requirements for this program are at the county level and include a project conservationist and a field technician. The conservationist would handle administration, reporting, organizing activities, and overseeing the duties of the technician. He will also participate directly in activities directed at establishing conservation tillage and applied practices on the land. The technician would be directly responsible for establishing field demonstration plots, collecting and organizing information pertaining to the plots, and for providing technical assistance to local farmers on conservation tillage practices. The technician should have training in the area of crop production, since this project will focus on management rather than engineering methods for achieving sediment reductions.

Activities of Local and State Agencies

The supporting activities of agencies normally associated with agricultural and sediment control activities (ASCS, CES, EPA, SCS) are vital to program success. The programs cannot maintain credibility or acceptance without interagency support. This support should come in two general ways - formation of advisory groups and providing of ancillary services to amplify the work of the projects. A basin-wide position would be established for both SCS and the Cooperative Extension Service. Both positions would be responsible for the training of local project personnel and the setting up of administrative frameworks for each county.

Project advisory groups should be formed at the local and State levels. At both levels, agency personnel should be willing to allocate time to advising projects on best courses of action. The local advisory groups would meet with the project staff of its own area at least four times per year, while the State advisory group might meet in a joint session with all project staffs in its particular State, once or twice per year.

The local advisory group would be composed of the local county extension agent, District Conservationist, ASCS director, an SWCD administrator, and other interested local leaders, including those from agribusiness. The group would meet with the entire project staff and interested SWCD Supervisors to discuss project direction, performance and needs at the local level.

The State groups would be composed of State and area level representatives of ASCS, CES, EPA, SCS, and State Department of Natural Resources. They would probably meet in joint session with managers from all projects. Such an interaction would enable State agencies to have input to the projects, allow some Statewide coordination of efforts, and would allow project managers to voice concerns best expressed at the Statewide level.

At the local level, however, the most important functions of the local agencies will be activities in support of, or paralleling, the county project. For the projects to be most effective, the local populace must be aware that their local leaders support the same ends. The local SWCD, of course, will be directly responsible to the Managing Agency for project administration through its Board of Supervisors. SWCD would also provide housing for the project, plus publicity and technical assistance.

Project Approach

The majority of the project's initial year will be devoted to laying a firm foundation. During this time, the project conservationist will meet with and enlist the cooperation of local agency and agribusiness persons, establish advisory committees, hire the technician, secure necessary equipment, sign up initial farm cooperators, and begin an extensive information/education program.

A strong information education program is critical to project success. This program should have two main objectives - to promote the project itself, and to provide farmers with the best possible information on conservation tillage. The program should include both mass media and meeting approaches, and should involve local agency personnel. As the project progresses, the emphasis of the programs will shift from promotion to more education.

Beginning in the second year, the technician will be responsible for establishing demonstration plots and providing technical assistance to other farmers who are interested in conservation tillage, but are not directly involved in demonstrations. Careful records of cultural practices used on demonstration plots will be kept. Results of demonstration plots should be made available to the public on a yearly basis, and demonstration plots should be used as teaching aids at project-sponsored field days throughout the summer.

The combination education/demonstration/technical assistance program should continue for 4 years. During this time, the rate of adoption of reduced tillage should be monitored and reported to the Managing Agency by the Supervisors. Continued funding for an individual project during these 4 years should be contingent upon demonstrating increased adoption of con-

servation tillage. The Land Resources Information System (LRIS) would be updated and used to produce additional county resource information system packages, and to monitor the adoption of conservation tillage throughout the basin.

Tributary and Lake Monitoring

The tributary monitoring program is designed to measure change in sediment, nutrient and pesticide loads resulting from the recommended program. In order to accomplish this purpose, acceptable baseline data must be available. The only stations with the required data bases are the Maumee River, Portage, Sandusky (9 Stations), and Huron Rivers. Annual variability in sediment and nutrient transport are well characterized at these stations. The Honey Creek and Upper Honey Creek are priority areas because it is anticipated that large shifts toward no till and conservation tillage will occur there. Thus, changes in nutrient loads attributable to the program can be measured there. The program will monitor the six stations listed below for a total of 5 years.

Upper Honey Creek	Huron River
Honey Creek	Sandusky River
Maumee River	Portage River

The Surveillance Subcommittee of the Great Lakes Water Quality Board developed a Great Lakes International Surveillance Plan (GLISP). This document presents the basic framework for surveillance activities in the Great Lakes Basin as required in the 1978 Water Quality Agreement between the United States and Canada.

The Great Lakes International Surveillance Plan is an important element in the overall Great Lakes water quality process. This process relies on analysis, interpretation and communication of information obtained from monitoring material inputs as well as from observing the immediate and longer term effects of these inputs. Information analysis and interpretation includes evaluating trends, determining compliance with water quality objectives and standards, assessing the significance of violations and relating causes (material inputs) to effects (ecosystem quality). Results provide management with the information needed to establish policies, to determine the effectiveness of management actions, and to plan future strategies.

Elements in GLISP change annually in response to program resources and information learned in previous years. The USEPA Great Lakes National Program Office carries out the main lake monitoring for Lake Erie. It is essential that this activity continue to be funded if the main lake effects of the recommended program are to be determined.

TABLE 5 — Estimated Costs for County Demonstration / Implementation Projects

Component	5-Year Cost
Personnel Salaries	
Conservationist (5-years, at $25,000)	125,000
Technician (4-years, at $18,000)	72,000
Secretary (5 years, halftime at $7,500)	37,500
Fringe Benefits (at 20 percent of salary)	46,900
Overhead (at 25 percent of salary)	58,600
Publications	10,000
Travel	20,000
Telephone	5,000
Equipment	30,000
County Total	405,000
20-County Program Total	8,100,000

Program Costs

The projected costs for a given county project are given in Table 5. This budget assumes a 5-year salary for the project conservationist and 4 years for the technician. This represents the bulk of program costs. There is no cost sharing figured into this budget, as it is assumed that cost sharing will be available from ASCS. Table 6 shows the costs for the entire project. Included in the total are costs for the involvement of an Extension Agronomist and a Resource Conservationist for the full 10 years of the project. Also included are costs for Program Administration, as well as costs for the CRISP packages, the soil updates, and the monitoring of acceptance rates.

Program Costs	10-Year Period
$	$
20-County Cost at 405,000	8,100,000
Resource Conservationist SCS at 72,000/yr. (1)	720,000
Extension Agronomist at 64,000/yr. (1)	640,000
Managing Agency at 75,000/yr. (1) (2)	750,000
Education Program Publications and Consulting Including Extension and University	650,000
30 CRISP Package at 6,000 (2)	180,000
18 Soils Updates at 6,000 (2)	108,000
Tributary Monitoring	950,000
Monitor Land Cover (2)	150,000
Total	12,248,000

TABLE 6 — Estimated Total Program Costs for A Lake Erie Basin Conservation Tillage Program

(1) Includes fringe benefits, travel, and office overhead.

(2) Estimates are based on costs incurred by the Corps of Engineers for similar activities during the study period.

BENEFITS OF GREAT LAKES BASIN CONSERVATION TILLAGE PROGRAM

Conservation tillage on suitable soils is the most cost effective means of reducing nonpoint phosphorus loads to Lake Erie and its tributaries. By implementing the proposed conservation tillage program, nonpoint rural phosphorus loadings to Lake Erie are expected to be reduced by 2,030 MT per year by the year 2000. This exceeds the immediate IJC goal of reducing nonpoint U.S. sources by 1,700 MT per year. The selected 20 counties can, by themselves, achieve 65 percent of the estimated total achievable soil loss reduction and 80 percent of the IJC targeted reductions.

If the above phosphorus reduction goals were to be implemented by further removal of phosphorus from municipal treatment plants (i.e., from 1.0 MG/L to 0.5 MG/L phosphorus in effluent), the total cost is estimated as $128.7 million. Since the cost of a conservation tillage program to reach the same goals would be $12.25 million, the benefit-to-cost ratio of the proposed basin tillage program is 10:1.

The proposed program would result in a total Lake Erie phosphorus loading of 13,000 MT per year which is 2,000 MT per year higher than the long-term IJC Loading objective of 11,000 MT per year. To reach this ultimate goal, a combination of conservation tillage and additional removal at municipal treatment plants would be necessary. The estimated cost of this dual program is estimated at $111.6 million. The cost of achieving the 11,000 MT per year goal by additional point source removal only is estimated as $1.9 billion. Thus, the benefit-to-cost ratio of employing the combined approach would be 17:1.

Loss of valuable top soil from basin cropland will be reduced by 55 percent. Additional benefits include reduction in siltation of harbors with attendant reductions in dredging costs, reduced water treatment costs, and increased recreational and aesthetic benefits.

Implementation of the proposed program for the rehabilitation of Lake Erie can reverse historical phosphorus over enrichment, changing commonly algae-choked water, as in Figure 2, to a balanced multipurpose water resource, as shown in Figure 17.

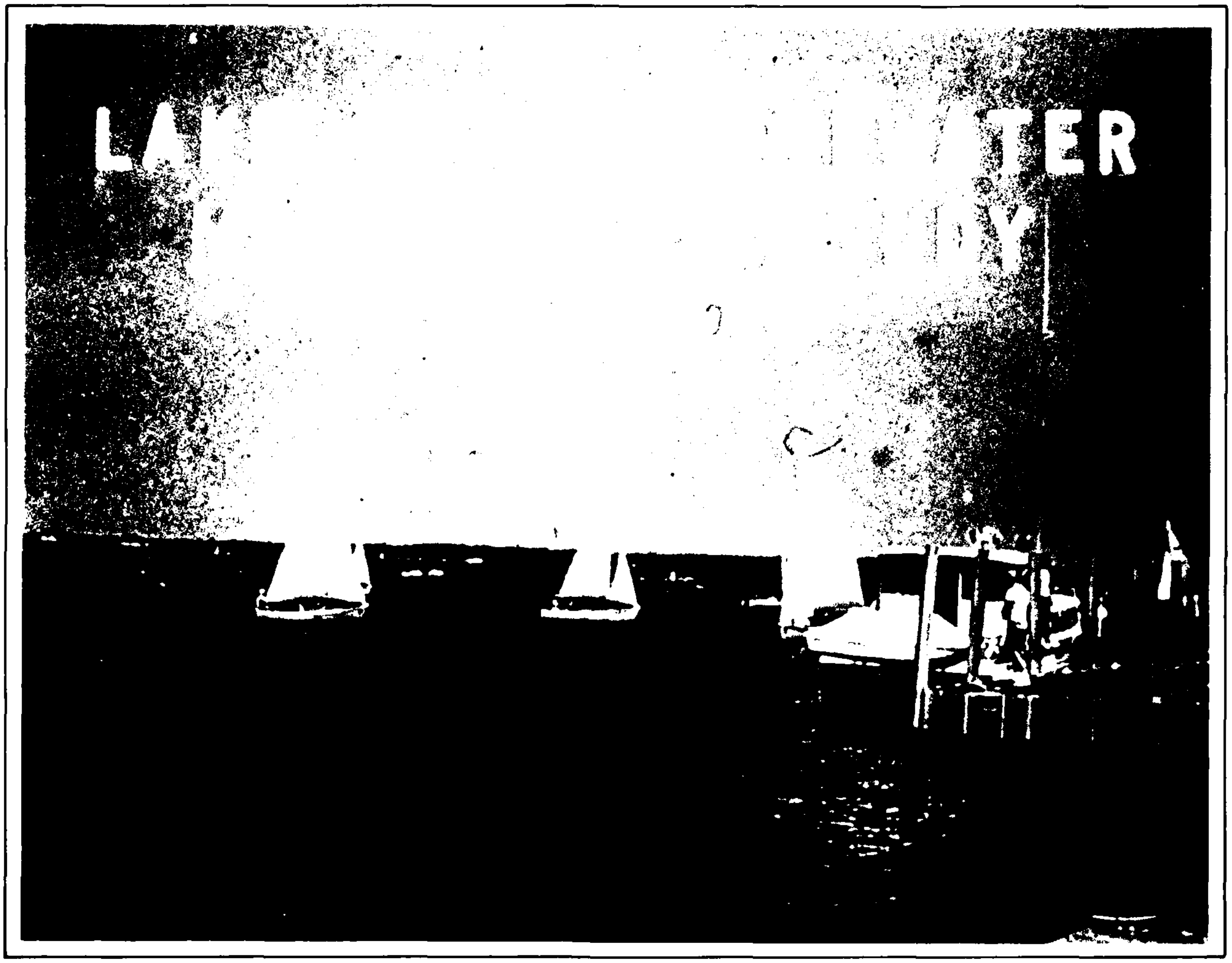


Figure 17
Multi-Purpose Water Resource.

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